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BULLETIN

OF THE

AMERICAN MUSEUM OF NATURAL HISTORY.

Volume XVI, 1902.

NEW YORK:
PUBLISHED BY ORDER OF THE TRUSTEES.

FOR SALE BY

G. P. PUTNAM'S SONS, NEW YORK AND LONDON
J. B. BAILLIÈRE ET FILS, PARIS;
R. FRIEDLÄNDER & SOHN, BERLIN;

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1902.

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Art. I, Jan. 16; Art. II, Feb. 1; Art. III, Feb. 6; Art. IV, Feb. 5; Art. V, Feb. 5; Art. VI, Feb. 5; Art. VII, Feb. 3; Art. VIII, Feb. 18; Art. IX, March 15; Art. X, March 31; Art. XI, April 7; Art. XII, April 7; Art. XIII, April 12; Art. XIV, April 23; Art. XV, April 16; Art. XVI, July 1; Art. XVII, June 28; Art. XVIII, July 12; Art. XIX, Aug. 18; Art. XX, Aug. 18; Art. XXI, Sept. 18; Art. XXII, Sept. 25; Art. XXIII, Sept. 25; Art. XXIV, Sept. 25; Art. XXV, Sept. 25; Art. XXVI, Oct. 11; Art. XXVII, Oct. 11; Art. XXVIII, Oct. 11; Art. XXIX, Oct. 11; Art. XXX, Nov. 3; Art. XXXI, Nov. 3; Art XXXII, Oct. 31; Art. XXXIII, Dec 20; Art. XXXIV, Dec. 12.

The edition of separates from the present volume was 350, of which 100 were for the authors, and 250 for the Library exchange list and for sale. Of Art. XXVI, by Dr. Hovey, 225 separates were published in addition to the usual number.

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BULLETIN

OF THE

American Museum of Natural History.

Vol. XVI, 1902.

NEW YORK:
Published by order of the Trustees.
1902.

276551

PUBLICATIONS

OF THE

American Museum of Natural History

The publications of the American Museum of Natural History consist of the 'Bulletin,' in octavo, of which one volume, consisting of about 400 pages, and about 25 plates, with numerous text figures, is published annually; and the 'Memoirs,' in quarto, published in parts at irregular intervals. Also an 'Ethnographical Album,' issued in parts, and the 'American Museum Journal.'

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Each Part of the 'Memoirs' forms a separate and complete monograph, with numerous plates.

Vol. I (not yet completed).

PART I.—Republication of Descriptions of Lower Carboniferous Crinoidea from the Hall Collection now in the American Museum of Natural History, with Illustrations of the Original Type Specimens not heretofore Figured. By R. P. Whitfield. Pp. 1–37, pll. i–iii, and 14 text cuts. September 15, 1893. Price, $2.00.

PART II.—Republication of Descriptions of Fossils from the Hall Collection in the American Museum of Natural History, from the report of Progress for 1861 of the Geological Survey of Wisconsin, by James Hall, with Illustrations from the Original Type Specimens not heretofore Figured. By R. P. Whitfield. Pp. 39–74, pll. iv–xii. August 10, 1895. Price, $2.00.

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PART IV.—A Complete Mosasaur Skeleton. By Henry Fairfield Osborn. Pp. 165–188, pll. xxi–xxiii, and 15 text figures. October 25, 1899.

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(*Continued on 3d page of cover.*)

BULLETIN

OF THE

AMERICAN MUSEUM OF NATURAL HISTORY.

VOLUME XVI, 1902.

Article I.—A NEW SPECIES OF ELK FROM ARIZONA.

By E. W. NELSON.

The Arizona Elk, the last of the large game mammals of America to become known to science, is already on the verge of extinction. So far as I have been able to learn, its range has been long isolated and in an area where the idea of game protection is very recent, and where even now the protection afforded by the game laws (owing to the remote situation) is more nominal than real. The present game law of Arizona prohibits the shooting of elk at all seasons, and it is to be hoped that an effort may be made to render this protection effectual.

The only specimens of this species now known are the two obtained by myself near the head of Black River in the White Mountains of Arizona. The type is in the National Museum, and the other specimen, represented by the skull and antlers of an old male, is in the American Museum of Natural History. The skull of the American Museum specimen is described and figured in this paper, owing to the temporary mislaying of the skull of the type.

I have found no published record of this species among earlier authors and the actual extent of its former range will be difficult to determine. My first knowledge of its existence was obtained in the fall of 1882, when some prospectors at Chloride, New Mexico, told me that elk inhabited the Mogollon Mountains near the extreme headwaters of Gila River. Nothing further was heard of it until the early months of 1884,

when I spent some time exploring the Indian ruins about the village now called Frisco, on the headwaters of the San

Fig. 1. *Cervus merriami*, ♂ ad. No. 16211, Am. Mus. Nat. Hist., near Springerville, Arizona. Topotype.

Francisco River in western Socorro County, New Mexico. During January I made a horseback trip about ten miles to the

eastward into the border of the Mogollon Mountains and saw a doe elk and two young bucks hanging by a hunter's cabin. At this time elk were reported to be not uncommon on the higher parts of the range, but the total number, from all

Fig. 2. *Cervus canadensis*, ♂ ad. No. 2910, U. S. Nat. Mus., Fort Berthold, North Dakota.

accounts, must have been very small compared with those then found in Colorado and farther north.

From 1885 to 1887, while living on my ranch at the eastern base of the White Mountains, near Springerville, Arizona, I

heard frequently of elk living in the higher and more remote

Fig. 3. *Cervus merriami*, ♂ ad. Same specimen as Fig. 1.

parts of these mountains, mainly along the border of the White Mountain Indian Reservation, near the head of Black

River (a tributary of the Gila). The local hunters reported them as not uncommon in this area where, during brief hunting

Fig. 4. *Cervus canadensis*, ♂ ad. Same specimen as Fig. 2.

trips between 1885 and 1888, I saw signs of their presence in various places. Their main range covered an area about 30

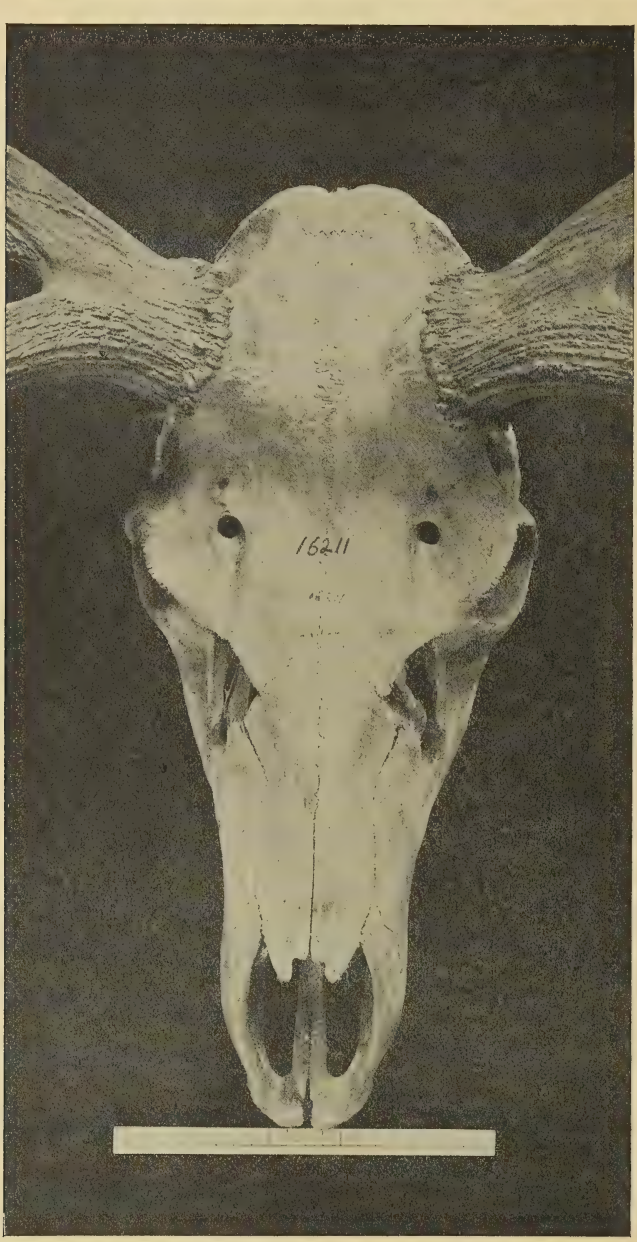

Fig. 5. *Cervus merriami*, ♂ ad. Same specimen as Figs. 1 and 3.

by 50 miles in extent, at an elevation from 8000 to 10,000 feet above sea level. This country forms the divide between the headwaters of the Little Colorado River and Black River and the high Prieto Plateau between the upper Black River and Blue River. At the time of which I write elk were far from numerous, but I never visited their territory without seeing signs, usually more or less recent tracks, and in fall the broken branches and barkless trunks of saplings, where the bulls had been rubbing their horns. The most abundant signs were found about some beautiful damp meadows in the midst of the dense fir forest on the rolling summit of the Prieto Plateau, between the Blue and the Black Rivers. Owing to the presence of hostile Apaches at that time, it was dangerous to linger in the country where we saw most of the elk signs, so we always pressed on to a safer district before doing much hunting. Outside the Indian country they were not common enough for one to hunt them with any degree of certainty. From 1884 to 1889 the white hunters did not kill a dozen elk in all this district.

Mr. W. W. Price, who made a collecting trip for mammals through the White Mountains during July and August, 1894, states: "So far as we could learn this animal is now confined to a small area in the higher White Mountains. Several were seen and a fine male was shot at about 9000 feet elevation on August 10. They feed in the dense fir woods and glades which clothe the upper slopes of the mountains." (Bull. Am. Mus. Nat. Hist., Vol. VII, 1895, pp. 257, 258.) A recent letter from my brother, Mr. F. W. Nelson, informs me that a local hunter found the trail of a bull elk near the head of Black River the present autumn (1901), and followed it for two days without obtaining a shot at the animal. This shows that the Arizona Elk still survives, and that it is pursued by local hunters regardless of the legal prohibition.

Cervus merriami, new species.

Type, No. 111639, ♂ ad., U. S. National Museum, collected August, 1886, at head of Black River, White Mountains, Arizona, by E. W. Nelson.

Distribution.—Formerly all of the higher parts of the White Mountains of Arizona and the Mogollon Mountains of western New Mexico. Now nearly extinct and limited to a small area in higher parts of the White Mountains (and possibly in the Mogollons).

Fig. 6. *Cervus canadensis*, ♂ ad. No. 2579. U. S. Nat. Mus., North Dakota.

General characters. — Nose darker and head and legs more reddish than *Cervus canadensis* from the northern Rocky Mountains, but paler than *C. roosevelti* Merriam, of the Northwest Coast region. Skull more massive with nasals broader and much more flattened, and upper molar series heavier and more curved. Antlers most like those of *C. canadensis* but with tip straighter, thus giving much longer chord from base to tip.

Summer pelage (type specimen).—Top of nose rich reddish chestnut brown becoming much paler and more yellowish along edges of upper lips; and paler, more reddish fulvous on cheeks, forehead, and crown; pale areas around eyes dull dark buffy; chin dingy buffy with large blackish brown spot on each side; front of ears pale buffy yellow; back of ears reddish brown; top of neck, entire back and sides of body faded grizzled yellowish brown, darkest along middle of back and shading into pale dingy yellowish on flanks; rump patch dingy yellowish white (not

strongly contrasting with rest of back) bordered along lower edge by narrow band of seal brown; underside of neck and body dark brown, darkest on neck and more reddish on belly; front of forelegs dark reddish brown becoming paler (nearly vandyke brown) on sides and with median line behind and around borders of hoofs reddish fulvous; hind legs similarly colored but paler along front.[1]

Winter pelage.[2]—"Body, above and on sides, pale yellowish brown, this color extending over entire outer surfaces of shoulders and hips and over all of buttocks and tail. Head and neck seal brown with pale areas around commissure and eyes; ears whitish at base and

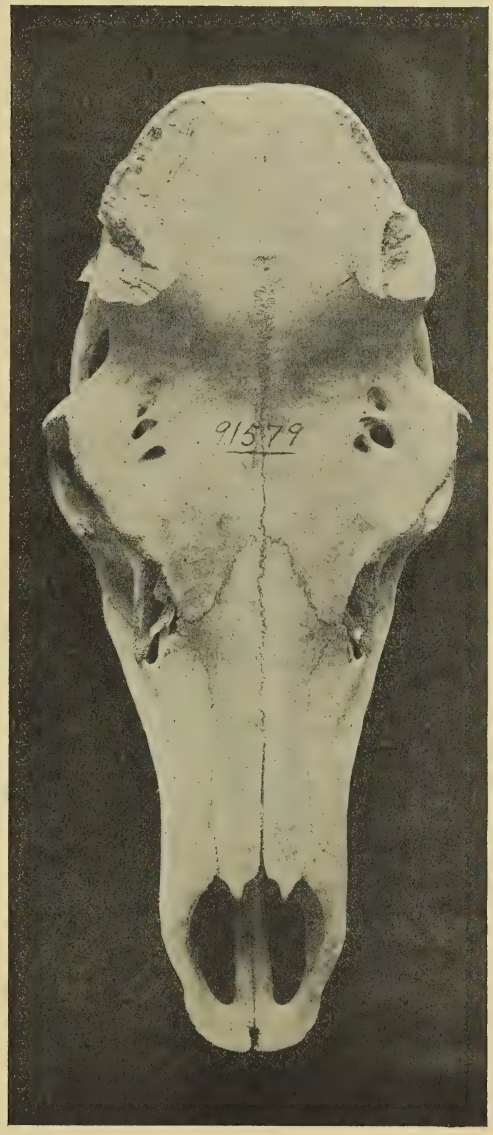

Fig. 7. *Cervus roosevelti*, ♂ ad. Olympic Mountains, Wash. Type.

[1] While dressing this skin the taxidermists of the National Museum found three bullets encysted in the thick hide about the neck and shoulders. One appears to be from a Springfield musket and the others from 44 cal. Winchester rifles.

[2] Dr. E. A. Mearns, U.S.A., has kindly given me the accompanying description of the winter pelage of *Cervus merriami*, taken from the skin of No. 16211, American Museum of Natural History. This specimen was secured by me in the White Mountains the fall of 1887 and passed into the hands of Dr. Mearns, who afterwards presented it to the American Museum of Natural History. Fortunately, Dr. Mearns entered a brief description of the pelage in his note book at the time, as the skin has since been accidentally destroyed.

liver brown on posterior surfaces. Sides of neck paler than underside of head and neck—the hairs being dark brown at base with broad fulvous tips and brown annulations. Under surface of body, with inner and posterior surfaces of legs dark seal brown, a band of same color extending upward and outward from inside of thighs toward hip joint. Front and outside of legs cinnamon rufous, varying to fulvous. Hoofs black with fringe of buff colored hairs at base."

Skull.—Cervus merriami has strongly marked skull characters. It differs strikingly from both *Cervus canadensis*, of the northern Rocky Mountains, and from *Cervus roosevelti*, of the Northwest Coast, in having the nasals remarkably broad and flattened; the palate narrow between the posterior molars and in the great zygomatic breadth and massive molars.

The skull, compared more in detail with that of *Cervus canadensis* (from Nebraska and North Dakota), has the facial region anteriorly to the zygomatic arch broader and more massive and the premaxillaries heavier and more strongly convex laterally, forming a broad, heavy muzzle; the nasals have a convex outline along the outer borders, giving them a somewhat lyre-shaped form, and are very broad and greatly flattened throughout their length, completely lacking the lateral compression near the posterior end which gives the top of the nose in *C. canadensis* a narrower, more ridge-like form. The interorbital and zygomatic breadths are greater but the parietal breadth is about the same. Owing to the approximation posteriorly of the upper molar series, the hinder part of the palate is narrow, especially between the last two molars. The upper molar series are more curved and the teeth broader and heavier.

Compared with *C. roosevelti* the skull of *C. merriami* differs in much the same way as it does from *C. canadensis* (from the region mentioned), but there are certain details which are not the same. The table of measurements indicates an even greater width of nasals for *C. roosevelti*, but this is more apparent than real, for the width measured near the posterior end of the nasals merely shows a considerable lateral expansion of the bony angles, and they become decidedly narrower anteriorly and have the same lateral compression along the basal part of the ridge as in *C. canadensis*. The skulls of *C. mer-*

riami and *C. roosevelti* anteriorly to the orbits are of nearly equal breadth, but *C. merriami* has greater zygomatic and parietal breadth. The palate of *C. merriami* is strikingly narrower posteriorly than *C. roosevelti*, the width of the palate of the latter even exceeding that in *C. canadensis*. The molar series are of about equal length, but are more curved and the teeth are more massive in *C. merriami*.

The following tables of measurements of skulls, teeth and antlers show comparative details of size in adult males of *Cervus merriami*, *Cervus roosevelti*, and *Cervus canadensis*.

In conclusion, I wish to acknowledge my indebtedness to Dr. J. A. Allen, Curator of Mammals of the American Museum of Natural History, for the loan of the only skull of *Cervus merriami* now available, and to the authorities of the U. S. National Museum for the use of material and for the series of photographs of skulls for illustrating this paper. My thanks are especially due to Mr. Gerrit S. Miller, Jr., Assistant Curator of Mammals, and Mr. Geo. B. Turner, taxidermist, of the National Museum, for favors received while studying the material.

COMPARATIVE MEASUREMENTS OF SKULLS of *Cervus merriami*, *Cervus roosevelti*, AND *Cervus canadensis*.

COMPARATIVE SKULL MEASUREMENTS. (All adult males.)	Occiput to front of premaxillæ.	Palatal length.	Length of nasals.	Greatest breadth of nasals.	Greatest orbital breadth.	Greatest breadth across premaxillæ.	Breadth across parietals.	Zygomatic breadth.	Breadth below lachrymal fossæ.
Cervus merriami, near Springerville, Ariz., No. 16211 Am. Mus. Nat. History (Topotype)	498	288	183	83	194	99	168	203	157
Cervus roosevelti, Olympic Mts., Washington, No. 91579 U. S. N. M., Biological Survey. (Type)	516	297	192	84	195	98	163	190	150
Cervus canadensis, Ft. Berthold, N.Dak., No. 2910 U. S. N. M.	500	288	172	70	185	89	170	186	156
Cervus canadensis, Republican Fork, Neb., No. 49402 U. S. N. M.	492	292	172	65	174	86	156	180	150

Measurements of Upper Molar Series. (All adult males.)	Total length of row.	Distance between alveoli.						Breadth of 2d M. at base.
		1st P. M.	2d P. M.	3d P. M.	1st M.	2d M.	3d M.	
Cervus merriami, No. 16211 Am. Mus. Nat. Hist	137	59	63	75	77	76	69	31
Cervus roosevelti, No. 91579 U. S. N. M.	138	65	69	73	82	82	80	29
Cervus canadensis, No. 2910 U. S. N. M.	137	58	70	76	80	79	77	29
Cervus canadensis, No. 49402 U. S. N. M.	128	58	70	77	80	78	76	27
Cervus canadensis, No. 2903 U. S. N. M., Ft. Berthold, N. Dak.	—	60	67	76	78	77	77	—

Measurements of Antlers.	Chord from burr to tip.	Distance along outside of curve.	Circumference above burr.	Spread at tip.
Cervus merriami, No. 111639 U. S. N. M. (Type)	1192	1410	268?	—
Cervus merriami, No. 16211 Am. Mus. Nat. Hist. (Topotype)	1067	1240	237	843
Cervus roosevelti, No. 91579 U. S. N. M. (Type)	980	1075	280	990
Cervus canadensis, Ft. Berthold, N. Dak., No. 2910 U. S. N. M.	926	1290	252	760
Cervus canadensis, Republican Fork, Neb., No. 49402 U. S. N. M.	820	915	183	770

Article II.—ZIMMERMANN'S 'ZOOLOGIÆ GEOGRAPHICÆ' AND 'GEOGRAPHISCHE GESCHICHTE' CONSIDERED IN THEIR RELATION TO MAMMALIAN NOMENCLATURE.

By J. A. Allen.

There seems to be a difference of opinion as to whether Zimmermann's 'Zoologiæ Geographicæ' [1] is citable as an authority in questions of nomenclature. Most systematic mammalogists appear to have ignored it altogether, but recently Mr. C. I. Forsyth Major has taken it as authority for a name applied to a West Indian species of Muridæ,[2] where he cites "*Castor piloris* Zimmermann, Zool. Geogr. 509 (1777)," for the animal named *Mus pilorides* by Desmarest in 1826.

Zimmermann's two works, the 'Zoologiæ Geographicæ' and the 'Geographische Geschichte,' are constructed on nearly the same general plan; the first is in Latin, the other in German. The latter, however, is not merely a German translation of the first, but an essentially different work.[3]

Zimmermann was one of the best mammalogists of his time, as regards his familiarity with the literature of the subject, and discriminating and conservative,—far more so than many of his contemporaries and successors. But as regards nomenclatural form he was not a model, even for his day, in this respect falling behind his contemporary Schreber, and being much more lax than Pallas and Erxleben. In both works Zimmermann, although binomial as regards technical names, often employed vernacular names only, for genera as well as species, even when defining them by a formal diagnosis; while in the case of species he was apt to cite the names given by previous writers as these authors used them, regardless of whether the generic element of the name conformed

[1] The full title is as follows:
Specimen | Zoologiæ Geographicæ, | Quadrupedum | domicilia et migrationes | sistens. Dedit, Tabulamque Mundi Zoogra- | phicam adjunxit | Eberh. Aug. Guilielm. Zimmermann, | Professor Mathes. et Phys. Collegii | Carolini Brunsvicensis | — | . . . . [=quotation from Pliny, 3 lines]— | Lugduni Batavorum, | Apud Theodorum Haak, et Socios. | MDCCLXXVII.—1 volume, 4to, pp. xxiv + 686, and map.

[2] Ann. and Mag. Nat. Hist. (7), VII, Feb., 1901, p. 206.

[3] "Auf diese Weise ist dies gegenwärtige Buch allerdings eine Originalschrift, die mit dem lateinischen nur einen gleichen Plan hat."—*Zimmermann*, Geogr. Gesch., I, Vorrede, [p. ii].

or not with his own genera. In both works, but especially in the 'Geographische Geschichte,' he employed, when using technical nomenclature, the binomial method in due form, and in each work named a number of species supposed by him to be new, in a perfectly citable manner.

The greater part of the second volume of the 'Geographische Geschichte' is devoted to a 'Verzeichniss aller bekannten Quadrupeden,' in which, following Pennant, he divided the Quadrupeds into four 'orders' (some of them with subdivisions), 44 genera, and 388 species (consecutively numbered from 1 to 388), with a large number of additional forms entered as "Unbestimmtere Arten." His treatment is thus taxonomically methodical. In the earlier work he followed closely the arrangement of Linnæus as given in the twelfth edition of the 'Systema Naturæ.'

In his later work he singularly ignores the new names he gave in his earlier work, adopting those of Erxleben instead of his own, even where Erxleben's names are of the same date, and in general following closely the nomenclature of Pallas and Erxleben.

While the 'Geographische Geschichte' has been cited by many subsequent systematic writers, especially by J. B. Fischer in his 'Synopsis Mammalium,' and the new names adopted when having priority, the 'Zoologiæ Geographicæ' has been as uniformly neglected, although careful scrutiny shows that both are equally entitled to recognition. In the 'Zoologiæ' rather more new names were given than in the later work, but when not synonyms of earlier names they in most cases conflict with names given by Erxleben in his 'Systema Regni Animalis,' with the result that Erxleben's names have been adopted while Zimmermann's have been overlooked. Fortunately for science, both authors often gave the same name to the same species, so that the uncertainty relates to the citation of the authority for the name rather than to the name itself. The explanation of this coincidence in names is generally obvious, the species having been based on the same sources of information, which in most cases suggested the names bestowed independently by the two authors.

As evidence that the two works were issued simultaneously, in addition to the date they each bear, neither author cites the other, while Zimmermann in his second and later work not only cites Erxleben constantly, but adopts his nomenclature, even, as already said, where it conflicts with that of the 'Zoologiæ Geographicæ.' Besides, both authors cite Schreber's 'Säugethiere' to about the same point.

In deciding what names are to be construed in a vernacular sense and what in a technical sense, in the case of the 'Zoologiæ,' great aid is rendered by Zimmermann's index to the work, which appears to have been prepared with care, and which apparently clearly distinguishes whether a name is employed in a vernacular or in a technically nomenclatural sense. Further aid is furnished by the key to his map.

The 'Zoologiæ Geographicæ' is divided into four chapters, each treating of different aspects of the general subject. Chapter III is systematic and corresponds to the 'Verzeichniss' portion of Volume II of the 'Geographische Geschichte,' although some new names are given in other parts of the work.

Following is a list of the new binomial names appearing in both of Zimmermann's works, with their recognized equivalents. Those in current use, or entitled to adoption, are distinguished by being printed in heavy-faced type.

I. 'Zoologiæ Geographicæ.'

Dama virginiana (pp. 351 (in text) and 532, index, and map) =[Cervus dama] americanus *Erxleben*, 1777 (if Erxleben's name be citable) =Cervus virginianus *Boddaert*, 1784. As shown by Zimmermann's Geogr. Gesch., II, 1780, p. 129, the name is adopted from Ray, and is based on Lawson and Pennant. (See further remarks on this question below, p. 18).

Bos gnou (p. 372) =Antilope gnou *Zimmermann*, 1780 (Geogr. Gesch., II, p. 102) =Connochetes gnou (*Zimm.*).

Viverra fossana (p. 385, footnote); indexed as Fossana. =Viverra fossa *Schreber*, pl. CXIV, 1776 (plate name).

Vespertilio canadensis (p. 457) =Vespertilio borealis *Müller*, 1776= Vespertilio noveboracencis *Erxleben*, whose name Zimmermann adopts in Geogr. Gesch., II, 1780, p. 418.

Dasypus duodecim-cingulus (p. 467) =Dasypus duodecimcinctus *Schreber*, 1776 (plate name).

Tigris fulva (p. 479)=Felis concolor *Linn.*

Tigris jaguarete (p. 480; indexed only as jaguarete)=Felis nigra *Erxleben*, 1777, whose name Zimmermann adopted in 1780.

Viverra izquepatl (p. 483)=Viverra vulpecula *Erxleben*, 1777=Viverra memphitis *Linn.*

Viverra chinche (p. 484)=Viverra mephitis *Schreber*, 1776 (not Viverra memphitis *Linn.*).

Lutra brasiliensis (p. 485)=Lutra brasiliensis *Zimmermann*, 1780.

Mustela voang-shire (p. 487)=Mustela galera *Erxleben*, 1777.

Mustela javanica (p. 488)=Mustela javanica *Zimmermann*, 1780=? Herpestes javanica *E. Geoffroy*, 1812.

Mustela quoll (p. 489)=?

Ursus albus (p. 489)=Ursus maritimus *Phipps*, 1774.

Talpa flava (p. 496)=Talpa europæa, γ flavescens *Erxleben*, 1777=Sorex aquaticus *Linn.*

Talpa caudata (p. 497)=Talpa longicaudata *Erxleben*, 1777=Sorex aquaticus *Linn.*

Talpa fusca (p. 497)=Talpa fusca *Kerr*, 1792=Sorex aquaticus *Linn.*

Talpa rubra (p. 497)=Talpa rubra *Erxleben*, 1777.

Sorex brasiliensis (p. 508)=Sorex americanus *Müller*, 1776=Sorex brasiliensis *Erxleben*, 1777=Peramys americanus (*Müller*).

Cavia javensis (p. 507)=Mus leporinus *Linn.*

Cavia akouchi (p. 508)=Cavia acouchy *Erxleben*, 1777.

Sciurus purpureus (p. 518)=Sciurus indicus *Erxleben*, 1777.

Sciurus versicolor (p. 520)=Sciurus variegatus *Erxleben*, 1777.

Sciurus mexicanus (p. 521)=Sciurus mexicanus *Erxleben*, 1777.

Yerboa gigantea (p. 526)=Jaculus giganteus *Erxleben*, 1777=Macropus giganteus (*Zimm.*) auct.

Moschus meminna (p. 530)=Moschus meminna *Erxleben*, 1777=Tragulus meminna (*Erxl.*).

Tragulus surinamensis (p. 530)=Moschus americanus *Erxleben*, 1777.

Cervus porcinus (p. 532); usually attributed to Zimmermann at 1780.

Cervus (vel potius) Capreolus mexicanus (p. 533)=Cervus mexicanus *Gmelin*, 1788. Referred by Zimmermann in 1780 to Cervus bezoarticus *Linn.* 1758, which has in part the same original basis (Hernandez) as Cervus mexicanus *Gmelin.*[1]

[1] *Cervus bezoarticus* Linn. was based on the "Mazama" of Hernandez, or rather on Hernandez's "Cap. XIV. De Mazama, seu Cervus" collectively and not on any particular species of the several treated under this caption, and is thus in such a way composite as to be beyond satisfactory restriction by the process of elimination, and is further complicated by references to South American species of deer mentioned by Marcgrave and Piso. The name is therefore unavailable in nomenclature, and cannot properly be assigned to the South Brazilian and Paraguayan *Cervus campestris* F. Cuvier, as has recently been done by Lydekker (Deer of All Lands, 1898, p. 287).

Cervus mexicanus, of both Zimmermann and Gmelin, was based on Pennant's "Mexican Deer" (including Pennant's citations). Pennant's first reference is to the Tuethlalmaçama of Hernandez, which Hernandez says was also called Berendo by the natives of Mexico. This animal, under both these names, is commonly and apparently correctly

Antilope leucopus (p. 541)=Antilope pictus *Pallas*, 1777=Antilope tragocamelus Pallas, 1776=Boselaphus tragocamelus (*Pall.*).

Antilope tzeiran (p. 543)=Antilope gutturosa *Pallas*, 1777=Gazella gutturosa (*Pall.*).

Antilope koba (p. 545)=Antilope koba *Erxleben*, 1777=?Antilope korrigum *Ogilby*, 1836.

Mus oeconomus (p. 668)=Mus oeconomus Pallas, 1778=Microtus oeconomus (*Zimm.*).

The Piloris, or Rat musqué of Rochefort, and the Potto are omitted from the above list as not being binominally named.

In addition to the above list of specific names there are four superspecific names which require consideration in reference to their tenability as designations for genera. These are *Marmotta* (p. 509), *Jerboa* (p. 522), *Dama* (p. 532), and *Capreolus* (p. 533).[1]

In treating of the *Mures* Zimmermann divided the genus *Mus* into two sections, "A. *Marmotta*," and "B. *Mures proprie sic dicti*." Under *Marmotta* he placed three species only, namely, (1) *Mus marmota* Linn., (2) *Mus monax* Linn., and (3) *Mus citellus* Linn., all Sciuromorphs. Under the second section he placed 26 species, all Murine except No. 26, the *Sciurus striatus* Linn.

To this extent his classification is an improvement on that of Linnæus. It is also to be noted that his use of *Marmotta* for a superspecific group carries back the name from Blumenbach (1799) to a date (1777) three years prior to the introduction of *Arctomys* (Schreber, 1780) for practically the same group.

Jerboa, named on page 522, and acccompanied by a formal diagnosis, includes five species of which the first three are Dipodine, the first being *Mus jaculus* Linn. *Jerboa* is almost the exact equivalent of *Jaculus* Erxleben, of the same date, even to the inclusion of the Giant Kangaroo (*Macropus*) by both authors. The constituents of the two are found, on

identified with the Mexican form of the Pronghorn (*Antilocapra americana*). As Pennant's description scarcely applies at all to this animal, but is a vague conglomeration of references to various species of deer, with a figure of malformed antlers from an unknown locality, the name *Cervus mexicanus* of Zimmermann and Gmelin is clearly untenable in nomenclature.

[1] See below for remarks on *Dama* and *Capreolus*.

analysis, to differ in the inclusion by Zimmermann of the Tarsier, which is omitted by Erxleben. *Jerboa* also is practically equivalent to *Yerboa* of Forster, 1778, and of *Dipus* Schreber, 1782, the type by elimination being in each case the same, *Mus jaculus* Linn.

Of the 33 new specific names published in the 'Zoologiæ Geographicæ,' four of the accepted names are accredited to Zimmermann's later 'Geographische Geschichte' and one to Pallas;[1] 17 (including a number of Zimmermann-Erxleben names) are synonyms of earlier names given by Schreber, Müller, Pallas, and Phipps, and three others are not identifiable. The remaining eight names are of even date with names given by Erxleben to the same species, five of them being identical with Erxleben's names and three different.

The question now arises, What is to be done with the rival tenable Zimmermann-Erxleben names? A comparison of the two works shows that in each case they have practically the same basis, the same date, and equal claims to recognition. As Erxleben's names have long been current, while Zimmermann's have been overlooked, there is no reason for now giving Zimmermann preference over Erxleben, except where Erxleben's names are of doubtful tenability, as in the case of the Virginia Deer considered below. This disposes of the case of *Jerboa* vs. *Jaculus*, as well as the rival specific names.

Some of Zimmermann's other names, however, seem to call for special remark, namely, his *Dama virginiana* and his "Piloris," as well as his use of the names *Dama* and *Capreolus*.

Dama virginiana *Zimmermann.*

Zimmermann, in treating of the Virginia Deer of Pennant in Section VII of his Cap. II (p. 351), claims its specific distinctness from *Cervus dama* of Linnæus, and refers to it in the body of the text as "*dama virginiana*," in possibly a non-nomenclatural sense; but in Section X of Cap. III, where in § III (pp. 531–535) he treats systematically the genus "*Cervus* Linn.," and

[1] These five names do not include the case of *Dama virginiana*, which is specially considered below.

divides the genus into two sections, "*a. Cornibus palmatis*," and "*β. Cornibus teretibus*," placing *Cervus alce*, *C. tarandus*, and *C. dama* in the first division and *Dama virginiana* and the other deer then known in the second division, the name *Dama virginiana* is published in proper binomial form, and is based exclusively on the "Virginian Deer" of Pennant (Synopsis, 1771, p. 51, pl. ix, fig. 2). It appears also in the index as a technical binomial name, and on his map, where in the 'Notarum' it stands as *Dama virginiana*, and is engraved on the map (over what is now western Pennsylvania) as *Dama virg.* He also employs it in his later 'Geographische Geschichte' (Vol. II, 1780, p. 129), where it is credited to Ray. Thus the long-current specific name for the Virginia Deer is carried back from Boddaert (1784) to Zimmermann (1777). That it should take precedence over Erxleben's "Differtne vere *americanus* uti Pennanto videtur?" (Syst. Regni Anim., 1777, p. 312), which some recent writers have brought into question as the earliest available specific name for the Virginia Deer, is beyond reasonable challenge. As I have claimed (Am. Nat., XXXIV, 1900, p. 318), Erxleben did not name, nor did he intend to name, the Virginia Deer in this interrogative phrase. Even Zimmermann in his 'Verzeichniss,' where he so scrupulously adopted all of Erxleben's names, even at the sacrifice of his own of even date with Erxleben's, did not cite Erxleben in this connection, for the evident reason that he did not consider that Erxleben had named the animal.

What, now, is the status of *Dama* as used consistently and repeatedly by Zimmermann, as the generic designation of the Virginia Deer? If tenable from Zimmermann it would long antedate *Odocoileus*, and all other generic names applied to the Virginia Deer and its allies. Other now current generic names have quite as slight a basis; and any author who would take *americanus* from Erxleben as the specific name of the Virginia Deer could not very consistently reject *Dama* as the generic name of the group. As shown above, Zimmermann evidently used *Dama* in a generic sense, with intent, for the Virginia Deer; even those who may question his intention

in the matter must admit that his use of it fulfills the nomenclatural requirements of the case. It therefore seems as necessary to accept *Dama* in place of *Odocoileus* as it does to reject *americanus* Erxleben for the specific name of the Virginia Deer, which should evidently stand as *Dama virginiana* Zimmermann.

Taking as a basis Miller and Rehn's recent list of the *Odocoileus* group (Proc. Boston Soc. Nat. Hist., Vol. XXX, No. 1, pp. 14–17, Dec., 1901), and including recent additions, the North American forms of the genus, under the above and a few other changes of nomenclature, will stand (adopting an alphabetic sequence) as follows:

1. Dama acapulcensis (*Caton*).
2. " cerrosensis (*Merriam*).
3. " columbiana (*Rich.*).
4. " c. schaphiotus (*Merr.*).
5. " c. sitkensis (*Merr.*).
6. " costaricensis (*Miller*).
7. " couesi (*C. and Y.*).
8. " crooki (*Mearns*).
9. " hemionus (*Raf.*).
10. " h. californica (*Caton*).
11. " h. cana (*Merr.*).
12. " h. eremica (*Mearns*).
13. " h. peninsulæ (*Lyd.*).
14. " h. virgulta (*Hallock*).
15. Dama leucura (*Doug.*).
16. " **lichtensteini,** nom. nov.[1]
17. " nelsoni (*Merr.*).
18. " thomasi (*Merr.*).
19. " tolteca (*Sauss.*).
20. " truei (*Merr.*).
21. " virginiana *Zimm.*
22. " v. borealis (*Miller*).
23. " v. louisianæ (*G. M. Allen*).
24. " v. macroura (*Raf.*).
25. " v. osceola (*Bangs*).
26. " v. texensis (*Mearns*).

In this connection the use of the name *Capreolus*, in a generic sense, for *Cervus mexicanus* Gmelin et auct., also requires mention, as there is no doubt of its pertinence to the *Odocoileus* group. As, however, it occurs one page later than *Dama* in Zimmermann's work, it must give place to *Dama*, although suggested as a preferable substitute for *Cervus* for Pennant's Mexican Deer. It is also untenable on account of its exclusive relation to an unidentifiable and therefore invalid species. (See footnote to p. 16.)

Piloris, or the Rat musqué of Rochefort.

As noted at the beginning of this article, Mr. Forsyth Major has ascribed the name "*Castor piloris*" to Zimmer-

[1] =*Cervus mexicanus* Lichtenstein, but not *Cervus mexicanus* of Zimmermann nor Gmelin. Lichtenstein's name being preoccupied, his *Cervus mexicanus* may be called **Dama lichtensteini.**

mann. That Zimmermann did not name the animal *Castor piloris*, but simply called it "Piloris," in a non-technical sense, is evident from his index where it is entered as Piloris, and not as *Castor piloris*, and from his general method of using names in Cap. III of the 'Zoologiæ Geographicæ.' Besides, in the 'Geographische Geschichte' (II, p. 360) he refers the Rat musqué of Rochefort to *Mus pilorides* Pallas. If the name *Mus pilorides* given to this animal by Desmarest in 1826 is preoccupied by *Mus pilorides* Pallas, 1786, as seems to be the case, the proper name of the Rat musqué, or Piloris, will be *Mus desmaresti* of Fischer, 1829,=*Megalomys desmaresti* (Fischer), or *Oryzomys desmaresti* (Fischer) for those who believe, with Mr. Forsyth Major, that *Megalomys* is not separable from *Oryzomys*.

II. The 'Geographische Geschichte.'

During the interval of three years between the publication of the 'Zoologiæ Geographicæ' and Vol. II of the 'Geographische Geschichte' quite a number of new mammals were indicated in the works of travellers and other non-technical writers to which Zimmermann gave names in his later work. It is also to be noted that he displayed superior astuteness over Erxleben in separating several species not recognized by the latter. His discrimination is further evinced through his treatment of many forms as "Unbestimmtere Arten," which he merely enumerated without either naming or giving them numbers.

The species newly named or renamed in the present work (all in Vol. II except the last) appear to be the following, in the order of their position in the work. Those at present recognized in nomenclature are indicated by heavy type.

Bos moschatus (Vol. II, p. 86)=Ovibos moschatus (*Zimm.*).
Cervus muntjak (p. 131)=Cervulus muntjak (*Zimm.*).
Tapir anta (p. 154)=Hippopotamus terrestris *Linn.*=Tapirus terrestris (*Linn.*).
Simia madarogaster (p. 176)=Simia maimon *Linn.*
Papio æthiops (p. 180)=?; not Simia æthiops *Linn.*

Cercopithecus kephalopterus (p. 185)=Semnopithecus cephalopterus (*Zimm.*) auct.

Cercopithecus mulatta (p. 195)=?

Simia porcaria (p. 197)=?; probably not Simia porcaria *Hasselquist*, 1762.

Cebus polykomos (II, p. 202, III, p. 272)=Colobus polykomos (*Zimm.*); the name is usually ascribed to "Schreber" or Illiger.

Lemur lori (p. 211)=Nycticebus tardigradus (*Linn.*).

Didelphis karkinophaga (p. 226).

Didelphis kenguru (p. 231)=Yerboa gigantea *Zimm.*, 1777=Macropus giganteus (*Zimm.*) auct.

Canis zerda (p. 247)=Fennecus zerda (*Zimm.*).

Viverra manguste (p. 286)=Viverra ichneumon *Linn.*

Latra [misprint for Lutra] **minima** (p. 317)=Chironectes minima (*Zimm.*).

Cavia patagonum (p. 328)=Cavia patagonica *Shaw*, 1801=Dolichotis patagona (*Zimm.*).

Sciurus inauris (p. 344)=Myoxus inauris *Zimmermann*, III, 1783, 275, based on Earless Dormouse, Pennant, II, p. 426=? Myoxus africanus *Shaw*, 1801=? Myoxus capensis *F. Cuvier*, 1829.

Myoxus chrysurus (p. 352)=Loncheres chrysurus (*Zimm.*)=Echimys cristatus *Desm.*, 1817.

Dipus hudsonius (p. 358)=Zapus hudsonius (*Zimm.*).

Sorex minutissimus (p. 385)=Sorex minimus *Linn.*

Sorex surinamensis (p. 386)=Surinamische Spitzmaus of Schreber=Sorex surinamensis *Gmelin*, 1788=Peramys brevicaudatus (*Erxl.*).

Erinaceus tendrac (p. 393)=Ericulus setosus (*Schreber*, 1778), plate name.

Erinaceus tanrec (p. 394)=Centetes ecaudatus (*Schreber*, 1778), plate name.

Manati gigas (p. 426)=Rhytina gigas (*Zimm.*). The generic name *Manati* is of even date with *Manatus* Storr.

Antilope marsupialis (p. 427)=Antilope euchore *Zimmermann* (ex Forster MS.), Geog. Gesch. III, 1783, 269=Antidorcas marsupialis (*Zimm.*). As the authors of 'The Book of Antelopes' (Vol. III, 1897–98, p. 58) freely admit, the name *marsupialis* has three years' priority over *euchore*, however unfortunate the fact.

Phoca fasciata (III, 1783, p. 277)=Histriophoca fasciata (*Zimm.*).

Of Zimmermann's 26 new names 12 are in current use, and one other clearly has priority; of the remaining 13, three are not readily identifiable, and the remaining 10 are synonyms of earlier names given by Linnæus, Schreber, and Erxleben. Thus 23 of Zimmermann's 26 new names are identifiable —a pretty favorable commentary on the character of his work and standing as a naturalist.

Article III. — THE CRANIA OF TRENTON, NEW JERSEY, AND THEIR BEARING UPON THE ANTIQUITY OF MAN IN THAT REGION.

By Aleš Hrdlička.

Plates I–XXII.

Attention to a possible antiquity of man in New Jersey was, according to Peter Kalm,[1] aroused among the occupants of the country as early as the beginning of the eighteenth century. Many of the inhabitants of Raccoon, in the then New Sweden, informed Kalm that when digging wells they found, at depths of from twenty to fifty feet below the surface, quantities of oyster, clam and mussel shells, reeds, logs, burnt wood, charcoal, "a great spoon," "such a trowel as the Indians make use of," etc., from which finds they concluded that man must have inhabited the region in remote times.

Neither these, nor any other finds of a similar nature that may have been made since, up to the middle of the past century, led to any systematic investigation of the subject. In the early part of the latter half of the nineteenth century, however, there arose in various parts of New Jersey an interest in collecting Indian implements. One of the noteworthy collections of this nature in the early fifties was that made by the Rev. Samuel Lockwood, who was the first to investigate the great shellheap at Keyport. Soon after, Mr. Michael Newbold, of Burlington County, N. J., started to form his collection. In 1872 Dr. Charles C. Abbott, of Trenton, began a systematic gathering of the numerous implements of stone found in and about Trenton and along the Delaware River,[2] and this may be said to mark the transition period from the empiric to scientific archæological work in the State and particularly in the Delaware Valley.

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[1] Kalm, Peter, Travels into North America, Warrington, MDCCLXX, v. I, pp. 353–359.

[2] Dr. Abbott's letter, February 21, 1901.

Dr. Abbott published a number of reports on his work, the most important of which are the 'Stone Age in New Jersey' (Smithsonian Report, 1877); the First and Second Reports on the 'Paleolithic Implements from the Glacial Drift, in the Valley of the Delaware River, near Trenton, N. J.' (1877–8), and his volume entitled 'Primitive Industry' (1881).[1] In these communications, particularly in the 'Second Report,' Dr. Abbott, besides describing the stone implements the manufacture of which can unquestionably be referred to the Lenape, points also to others of a somewhat different and inferior workmanship and found in different, lower deposits, particularly the Trenton glacial gravels, which implements he believes were made by "a still ruder race" than the Indians, a race that preceded the latter in that particular region.

The publications referred to aroused very much and prolonged interest as well as contention; they became the incentives of a thorough scientific research in the Delaware Valley, a research lasting to this date and still far, it may be hoped, from its conclusion. The motive power of the systematic archæological investigations about Trenton since 1878 has been Prof. F. W. Putnam. Professor Putnam conducted the research first for the Peabody Museum, then for the Columbian World's Fair of 1893, then again for the Peabody Museum, and since 1895 for the American Museum of Natural History. He has interested two patrons of American research in the work,—the Duke of Loubat and particularly Dr. Frederick E. Hyde. These gentlemen have generously for several years past supplied the funds for the exploration. Since 1890 Mr. Ernest Volk, Professor Putnam's carefully trained and painstaking assistant, has dug over, with a trowel, large portions of ground along the Delaware River south of Trenton.

Among the numerous and interesting results of Mr. Volk's work was the unearthing, from several burial places, of a considerable number of human skeletons, which are in the osteological collections of several Museums (Peabody

[1] For other publications on the subject by Dr. Abbott, see Bibliography.

Museum, Cambridge; Field Columbian Museum, Chicago; University of Pennsylvania Museum, Philadelphia; and the American Museum of Natural History, New York City). Besides his regular work, Mr. Volk, and, independently of him, Dr. Abbott, who has never lost his keen interest in the archæological problems of the Delaware Valley, have for many years watched the various public and railroad excavations, and the accidental finds made by others. Among the results of this watching has been the acquisition of three crania, a fragment of a frontal bone, parts of a parietal and of a temporal bone, a portion of an inferior maxilla, and a tooth. Some of these specimens rank with the most important archæological finds from the Trenton region. The most recent discovery, and from its geological position and the circumstances relating to its finding a highly important one, is a cut piece of human femur. We shall return to these specimens later.

In 1898 I visited the locality of the finds and received a kind invitation from Professor Putnam to examine the human remains from Trenton in the collection of the American Museum of Natural History. In 1899 Dr. Frank Russell, of Cambridge, published in the 'American Naturalist' [1] a paper on the 'Human Remains from the Trenton Gravels,' in which he gave measurements and some description of three of the Trenton crania preserved in the Peabody Museum. These crania Professor Putnam enabled me to compare with those now in the New York and Cambridge collections, and I shall be able to supplement somewhat the data of Dr. Russell, who worked under the great disadvantage of very limited material. Due to the courtesy of Dr. Geo. A. Dorsey, I am further able to include with my other measurements those of four relatively recent Lenape skulls, which were kindly sent to me for examination from the Field Columbian Museum in Chicago. The material thus gathered, though not all that could be wished for, will, I believe, prove not without value in the solution of the anthropological problems that have arisen, in consequence of other finds, about Trenton.

[1] Vol. XXXIII, February, 1899, pp. 143–155, with figs.

Description of the Finds of Human Bones in the Delaware Valley.

In the majority of the cases the only find made, or the only part of the find utilizable for description and measuring, on account of damage to or bad preservation of other bones, is the skull. In the description of these crania it is desirable in the first place to establish the prevalent cranial type of the region and in consequence of this I shall first enumerate Mr. Volk's numerous finds during his regular excavations. These finds were all made, as mentioned before, on the northeastern side of the Delaware River, south of Trenton. The country in this location consists partly of a terrace of glacial origin and partly of "low lands"; the terrace rises from forty to fifty feet above these latter.[1]

The Terrace and Low Lands Finds [2].—Mr. Volk's attention to these parts was drawn in 1888, by the accidental ploughing up on the Lalor farm of parts of a human skeleton. The subsequent exploration of the field, the neighboring parts of the terrace, and the adjoining low lands, led to the unearthing of about one hundred burials.

The surface soil both on the terrace and in the low lands, shows numerous signs of occupation by the Indians.

The graves on the terrace and in the low lands "varied in depth from a mere surface burial, where the body had apparently been laid down on the surface and the ground heaped over it, to that sunk three feet below the present surface."

Of the skeletons but a few were in a fair state of preservation; in the majority of instances the bones were partially and in some cases, particularly in one locality in the low lands, almost totally decayed. Very few objects were found with the skeletons.

The Deep Burials at Abbott's Farm.[3]—On April 21, 1899, Mr. Volk dug a deep trench on Dr. Abbott's farm, which is located on the terrace a little southeast of Trenton, adjoining

[1] See Atlas Sheet No. 8, Geological Survey of New Jersey.
[2] Locations indicated on the accompanying map (Fig. 1). The particulars as to the burials are mostly extracted from written reports by Mr. Ernest Volk to Prof. F. W. Putnam.
[3] See accompanying map (Fig. 1).

the low lands. At the depth of six feet from the surface, "beneath two feet of black soil and four feet of yellow loam and stratified sand," " neither of which layers showed any disturbance," were found two small lots of human bones. There were fragments of skulls and some long bones, most of the

FIG. 1. Map showing the locations of the various finds of Indian Bones about Trenton.

pieces showing advanced disintegration. "The bones rested upon a stratum of whitish, clean, sharp sand, which is five inches above the bed of heavy boulders mixed with broken limonite, a stratum known as the Columbia gravel. A reddish layer of three inches in thickness formed the bed for the bones and partly covered the same." "An argillite implement was found near lot No. 1 of the bones"; and four

feet from the same lot of bones, six and a half feet below the surface, were found two conical pieces of a dark brown pigment. No other bones, stone implements, or pieces of pottery were found in the layers above the burials. The trench dug ran parallel with (and on the north side of) a little stream that has deepened its bed in the terrace to a depth of forty feet at the edge of the same.

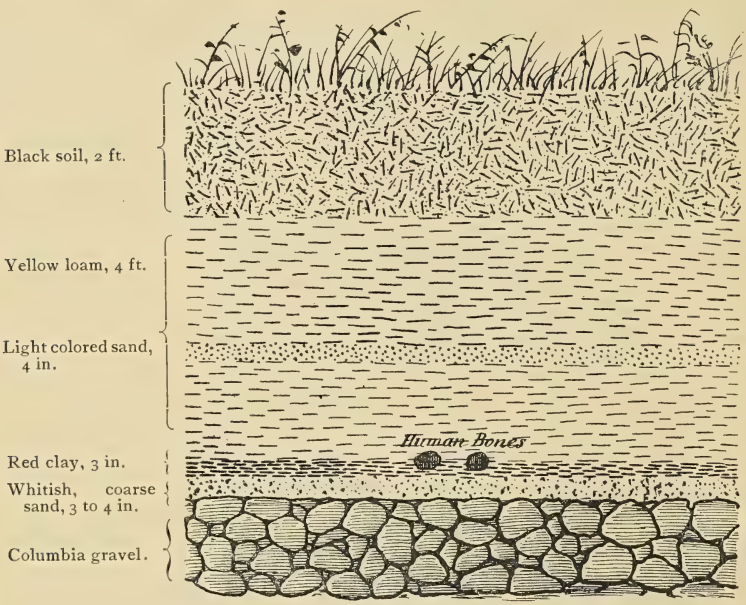
Black soil, 2 ft.
Yellow loam, 4 ft.
Light colored sand, 4 in.
Red clay, 3 in.
Whitish, coarse sand, 3 to 4 in.
Columbia gravel.
Human Bones

FIG. 2. Deep Burials at Abbott's Farm, discovered April 21, 1899. (Drawn by E. Volk on the date of the find.)

On April 28 Mr. Volk found another small lot of bones in the same trench. "Over these bones, but in no connection with them, there was noticed a little pit in the soil." "These bones were at a slightly less depth than those found April 21"; "they were surrounded by a reddish sandy soil." At slightly below the bottom of the pit was found an argillite implement.

The Accidental Finds.—The "Gasometer" Skull: This cranium [1] "was found in the excavation made for a gaso-

[1] Dr. Abbott's letter to me, Dec. 15, 1900.

meter on the northeast side of Warren St., Trenton." The find was made in 1879. Warren St. is situated near the bank of the Delaware (a little more than one square from the same), not far from the Assunpink Creek, and on rather low ground. "The excavation was of a circular form and deep. The material removed was mostly gravel, not distinctly strati-

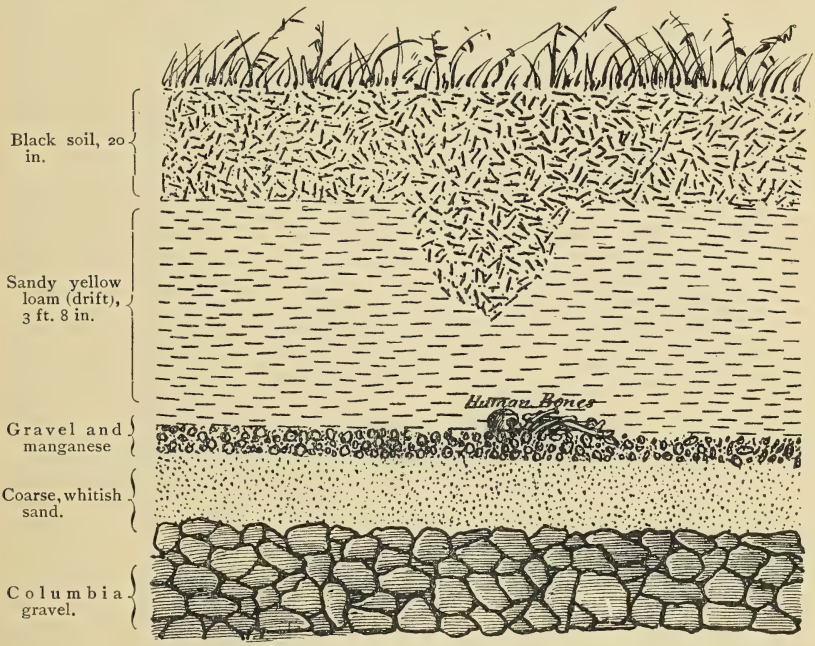

FIG. 3. Deep Burials at Abbott's Farm, discovered April 28, 1899. (Drawn by E. Volk on the date of the find.)

fied and coarser at the surface than beneath. The skull was found *in sand*, at the bottom of the excavation and not very far from the centre, about twelve feet from the surface." The skull was discovered by a laborer and a piece of it was accidentally cut off by his shovel. The specimen was taken by the foreman of the laborers and given to a druggist, from whom in turn it was obtained by Dr. Abbott, who gave it the same year to the Peabody Museum. "I took every means," Dr. Abbott proceeds, "to get correct details about the find;

and the history of the same as given to me by two individuals, without a knowledge on the part of one of the other's account, tallied in every particular." "When found the skull was tightly filled with sand." [1]

The Burlington County Skull. — Together with the "gasometer" specimen, Dr. Abbott gave in 1879 to the Peabody Museum a cranium found in the northern portion of Burlington County, New Jersey, about twelve and a half miles S.S.E. from Trenton. Dr. Abbott's detailed account of this find is as follows: [2] "The specimen was found by a man—name unknown—who gave it to Mr. Michael Newbold, an enthusiastic collector of Indian relics of his neighborhood." "Mr. Newbold, not liking to have so unattractive an object in his private museum, exchanged it for some stone implements and I procured it from the man with whom he made the trade. Having secured the specimen, I immediately visited Mr. Newbold and verified the statements made by the man from whom I got the skull. The specimen was not ploughed up. Mr. Newbold's information was to the effect that it had rolled out of the bank of a brook running through a field. The geology of the locality is cretaceous, and here the green sand marls and stratified clay and sand are overlaid by the 'southern-drift,' as the white pebbles and yellow sand are called. Over this is a rich alluvial deposit, but this is not a uniform covering, the gravel often being exposed for considerable areas. It was in this 'southern drift,' unassociated with other bones, that the skull was found." The field where the skull was found lay a little west or slightly southwest of Sykesville, in a region considerably more elevated (up to 205 feet [3]) than that about Trenton.

The Riverview Cemetery Skull.—This specimen, now also in the Peabody Museum, was procured in 1887 by Mr. Volk, whose account of the find is as follows: [4] "A man with whom I was acquainted, employed in digging graves in the Riverview Cemetery, told me of a skull he had found in a new plot, in

[1] Dr. Abbott's letter of Dec. 18, 1900.
[2] Letter of Feb. 11, 1901.
[3] See Sheet No. 12, Atlas Geological Survey of New Jersey.
[4] Mr. Volk's written report to Prof. F. W. Putnam, Feb., 1901.

which no burials had been made before. On my arrival at the cemetery he showed me the place; it was an elevated part of the ground and now there is one grave there. The man told me that when he dug that grave he struck with his spade, at the depth of about three feet, a human skull. There were no other bones there, but he noticed a few black lines in the soil." The workman gave the skull to Mr. Volk, who in turn gave it to the Peabody Museum. Upon examining the deposits as disclosed in the grave, Mr. Volk found "6 to 10 inches of black soil, about 18 inches of yellow drift, and then stratified sand and gravel. The skull, according to the information of the man who found it, was in the apparently undisturbed sand and gravel."

Fragments.—A human third molar, with its root artificially polished into a pyramidal form, a piece of a temporal bone, and a portion of a lower jaw, were found on different occasions between 1882 and 1885 by Dr. Abbott at various depths in the Trenton gravels, exposed by a railroad cut [1] and by removals of gravel for a road.

In 1895, Dr. Abbott found another fragment, a piece of a frontal bone. This lay "at a depth of about four feet in what is called 'Columbia gravel', and was not an intrusive object." [2]

Finally, in December, 1899, Mr. Volk, in watching a railroad excavation, found and photographed in situ, seven and a half feet from the surface, in a layer of sand underneath an overhanging layer of glacial gravel, a portion of a human femur. The bone shows cuts and perforations. The detailed archæological data about this specimen, and my examination of the same have been reported upon [3] and will be published later.

A few days later, in the same cut, about 30 feet from the place where the femur was discovered, Mr. Volk found a piece of human parietal bone lying on the talus that had formed within a few days by the crumbling down of the gravel.[4]

[1] A report on the tooth by Abbott in Proc. Boston. Soc. of Nat. Hist., XXII, p. 96.
[2] Dr. Abbott's letter, Feb. 11, 1901.
[3] By Professor Putnam, before Section H., A. A. A. S., New Haven Meeting, Dec., 1899.
[4] From Mr. Volk's reports to Prof. Putnam.

Of the above enumerated fragments those found by Dr. Abbott are in the Peabody Museum, those found by Mr. Volk, in the American Museum of Natural History.

Historical Remarks.

Before entering on a description of the above material, it will, I believe, be of advantage to give a brief survey of our knowledge concerning the inhabitants of the Delaware Valley and neighboring regions at and before the advent of whites.[1]

At the arrival of whites the entire region subsequently known as New Jersey belonged to the Lenape or Delaware Indians. The settlements of the nation extended "from the Mohicannituck (Hudson River) to beyond the Potomac," and "from the heads of the great rivers, "Susquehannah" and Delaware," to the Atlantic Ocean (Heckewelder). The neighboring tribes on the north (Mohegans, Narragansets, Pequots, etc.) as well as those on the south (Nanticokes, those of the Powhatan Confederacy, etc.), all acknowledged their relationship to the Delawares and were very probably branches of the same people. No ties, besides those of an early association and a joint migration eastward, seem to have existed between the Lenape and the Mengwe or Iroquois.

The Lenape in New Jersey were divided into three large families, or, as Brinton calls them, "sub-tribes," namely, the Minsis (the Wolf), the Unamis (the Turtle), and the Unalach-

[1] Literature consulted: Capt. John Smith's Works, 1608–1631, edit. Arber, Birmingham, 1884; Wm. Penn, Letters, 1683; G. Thomas, Hist. of New Jersey, London 1698; Thomas Campanius Holm, A Short Descript. of New Sweden, etc., orig. in Stockholm 1702, transl. by du Ponceau, Mem. of the Hist. Soc. of Penn., v. III, Phila. 1834; Acrelius T., A History of New Sweden, Stockholm 1759, Mem. Hist. Soc. Penn., v. XI, 1874; Sam. Smith, The Hist. of the Colony of Nova Caesaria or New Jersey, Burlington 1765; Peter Kalm, Travels into North America, London 1770–71; Loskiel G. H., Hist. of the Mission of the United Brethren among the Indians in N. A., London 1794; Geo. Chalmers, in Political Annals of the Present United Colonies etc., 1780 (cont. in N. Y. Hist. Soc. Collections, 1868); John Heckewelder, History, Manners and Customs of the Indian Nations who once inhabited Pennsylvania and the Neighboring States, Phila. 1819, Mem. Hist. Soc. Penn., v. XII, 1876; also MSS; James Grahame, The Hist. of the Rise and Progress of the United States of North America etc., London 1827 (new edits. 1836, 1845); Thos. F. Gordon, Hist. of New Jersey, Trenton 1834; J. Curtis Clay, Annals of the Swedes on the Delaware, Phila., 1835; Yates & Moulton's New York; Isaac Mickle, Reminiscences of Old Gloucester etc., Phila., 1845, Camden 1877; The Aborigines in New Jersey, A. Gifford, Proc. N. J. Hist. Soc., v. IV, Newark 1850, pp. 163–198; The Lenape and their Legends, D. G. Brinton, Phila., 1885, etc.; for further references see text.

tigos [1] (the Turkey); these families, it seems, were eventually subdivided into numerous smaller groups which bore distinct names.[2] The three parts of the tribe occupied special regions, but it has not been reported whether the boundaries of these regions were stable and definite. The Minsis, according to Heckewelder,[3] "had chosen to live back of the two other tribes and formed a kind of a bulwark for their protection." "They extended their settlements from the Minnisink, a place named after them, where they had their council seat and fire, quite up to the Hudson on the east, and to the west or southwest far beyond the "Susquehannah"; their northern boundaries were supposed originally to be the heads of the great rivers Susquehannah and Delaware, and their southern boundaries that ridge of hills known in New Jersey by the name of Muscanecun, and in Pennsylvania, by those of Lehigh, Cohnewago, etc." [4]

The respective territories of the Unamis and particularly that of the Unalachtigos are even less well defined than that of the Minsis. Generally speaking, the Unalachtigos occupied

[1] These designations are not translations of the terms in the parentheses, but "refer to the location of these sub-tribes on the Delaware River," Minsi (from *minihin*, to be scattered, and achsin, stone) meaning "people of the stony country" or "mountaineers"; Unami (from nahen, down-stream), means "people down the river"; and Unalachtigo (from wunalawat, to go towards, and t'kow or t'kou, wave) means "people who live near the ocean." Wolf, Turtle and Turkey are the totemic designations of the three sub-tribes. Brinton, *op. cit.*, p. 34.

[2] From the above three tribes sprang in course of time many others "who, having for their own conveniency, chosen distant spots to settle on, and increasing in numbers, gave themselves names or received them from others." Heckewelder, Hist. etc. of Indian Nations, p. 53; see. also p. 51, *ibid.*

[3] *Op. cit.* p. 52; see also H.'s MS., Communication to Dr. Miller, 1800, in the collections of the N. Y. Histor. Soc.

[4] Brinton (*op. cit.*, p. 37) is of the opinion, on what grounds not stated, that the extent of the territory of the Minsis as stated here is too great. In his words, "that at any time, as Heckewelder asserts, their (Minsi) territory extended up the Hudson as far as tide-water, and westward 'far beyond the Susquehannah,' is surely incorrect. Only after the beginning of the eighteenth century, when they had been long subject to the Iroquois, have we any historic evidence that they had a settlement on the last named river." It seems, however, that even if the presence of the Minsis on or beyond the Susquehannah may be open to contention, their presence along the Hudson is well established. Gifford (The Aborigines of N. J., p. 180), states "the Minsi tribe extended as far on the west banks of Hudson as Tappan." Yates & Moulton (Hist. of N. Y., v. I, p. 225), place the Minsis even further east, "from Long Island to and beyond Minnisink." According to Ruttenber (Hist. of the Indian Tribes of Hudson's River, p. 50), the territory of the Minsis "extended from the Katskill mountains to the head-waters of the Delaware and Susquehanna river, and was bounded on the east by the Hudson; their council-fire was lighted at Minisink (about 10 miles south of Maghackemek, New Jersey)." The Unamis (see p. 89 *et seq.*) joined the Minsis on the south somewhere about Stony Point. Going further than this, Ruttenber gives (p. 93 *et seq.*) the various subdivisions of the Minsis along the Hudson and their location (the Waorenecks about Dans-hammer; Waranawonkongs, from Kattskills to Saugerties. Mamekotings, west of Shawangunk mountains; Wawarsinks, in the district of country which still bears the name; Katskills, north of Saugerties).

a region nearer the sea and somewhat further south than the Unamis, and the territory of these latter lay between that of the Unalachtigos and that of the Minsis. The principal seat of the Unalachtigos was near where Wilmington now stands (Brinton). The Unami territory bordered the Raritan Bay with probably a part of the ocean further southward, the New York Bay and the lower part of the Hudson River, extending well into the present State of New Jersey.[1]

A number of the Lenape subdivisions were settled along the Delaware River and its affluents. This river was the favorite of the Delawares (Yates & Moulton), and was named by them the Lenape-Whittuck (or Whittituck), *i. e.*, the stream of the Lenape. To which of the three main portions of the tribe the various chieftaincies placed by different writers along the Delaware River belonged, has not been ascertained, but the probability is that most of those located between the Lehigh and Schuylkill Rivers were parts of the Unamis.

The numbers and names of the chieftaincies along the Delaware differ somewhat with different authors, and the locations given are, naturally, not as accurate as may be desired; nevertheless the data furnished by the different writers on the subject are not incompatible and enable us to obtain a fair idea of the native population in the Delaware Valley at the advent of the Europeans. The following list of chieftaincies, along and near the Delaware, from Cape May and the Delaware Peninsula to the northern limits of New Jersey, is constructed on the basis of the data furnished principally by John Smith, De Laet, Evelin, N. J. Vischer and N. Vischer's maps, Campanius, Acrelius, and Proud.[2]

[1] "When the Europeans first arrived at Yorck Island, the great Unami Chief of the Turtle tribe resided southward, across a large stream or bay, where Amboy now is" (Heckewelder MS., q. by Yates & Moulton, Hist. of N. Y., p. 225). Ruttenber (*op. cit.*, p. 89 *et seq.*) gives the distribution of the subdivisions of the Unamis as follows: "The Navisinks or Neversinks, on the Highlands south of Sandy Hook; the Raritans, in the valley and along the river of that name; the Hackinsacks, in the valleys of the Hackinsack and Passaic Rivers, council fire at Communipaw; the Aquackanonks, on the site of Patterson, and probably in a portion of the centre of New Jersey; the Tappans, from the Hackinsack River to the Highlands on Hudson; and the Haverstraws, north of Tappans, up to the Stony Point."

[2] De Laet, Novus Orbis, Lib. III, 12, after T. Mickle, Reminiscences of Old Gloucester, etc., Phila., 1845, p. 1; Evelin, in Beauchamps Plantagenet's New Albion, 1648, p. 20, also in Mickle, *op. cit.*, in Smith's History of New Jersey, 2d ed., and in Brinton's Lenape, pp. 41–42; maps of the Vischers (father and son), Amsterdam, 1656 and 1683; Reinier and Josua Ottens map (after N. Vischer), Amsterdam, 1740; Smith, Campanius, Acrelius, and Proud in works cited before.

Indians along the Delaware Bay and River on the West.[1]

Tockwoghs, over the central and upper portion of the Delaware Peninsula; John Smith, 1., Vischers's and Reinier's maps.

Kuscarawaogs, over the southern portion of the Delaware Peninsula, south of the Tockwoghs, John Smith, 1., over the lower (eastern) portion of the peninsula, Vischers's and Reinier's maps.

Atquanachukes, on the Delaware Peninsula, north of the Tockwoghs, John Smith, 1., to the north of the bend of the Delaware River below Philadelphia, Vischers's and Reinier's maps.

Minquas,[2] opposite Cohansey Creek; De Laet, 1.

Andastakas, on Christina Creek, Del., Acrelius, 1., Proud, 1.

Okahokis, on and between Ridley and Crum Creeks; Brinton (Lenape, p. 38), 1.

Sauwanoos, in Pennsylvania, in a little higher latitude than Philadelphia, Vischers's and Reinier's maps.

Neshaminics, in Buck's Co., Pennsylvania, Acrelius, 1.

Sasquesahanough, above and slightly to the south of Sauwanoos; Vischers's and Reinier's maps; about the Sasquesahanough River, northwest from the northern point of the Chesapeake Bay, John Smith.

Minquaas, above Sasquesahanough; Vischers's and Reinier's maps.

Konekatays, above Minquaas, a little south of Minsis; Vischers's and Reiner's maps.

Indians along the Delaware Bay and River on the East.

Kekemeches, a little above Cape May; Evelin, 1.

Sewaposees, Sewapois, on Maurice River; De Laet, 1., Vischers's and Reinier's maps.

Siconesses, about Cohansey Creek; De Laet, 1., Evelin, m.

Mandes, in Salem Co.; Proud, 1.

[1] Abbreviations: m.=mentions but does not indicate location ; l.=location given by the author.

[2] This name is a source of considerable confusion. The same term was applied to a branch of Indians further north, in Pennsylvania; and by an allied, if not the same term, Mengwe, the Lenape designated all the Iroquois.

Narraticons,[1] on the Raccoon Creek, De Laet, 1., apparently in Salem Co., Vischers's and Reinier's maps.

Ermomex, near Fort Nassau, Vischers's and Reinier's maps; Eriwoneck, on the Pensaukin Creek; Evelin, 1.; Armewamexes, on Timber Creek, De Laet, 1.; probably modifications of the same name.

Manteses, or Mantas, on Mantua Creek, Gloucester Co., De Laet, 1., Evelin, m., Proud, 1.

Asoroches, on Coopers Creek; Evelin, 1.

Schackamaxons, about Kensington, near Philadelphia; Proud, 1., Acrelius, m.

Kemkoekes, above Camden; Vischers's and Reinier's maps.

Mingoes, Acrelius, m.; Proud, m.; Mingnosees or Machoerentinees, De Laet, m.; Maeroahkongs, De Laet, m.; possibly modifications of the same name; between Camden and Rankokas Creek.

Atrions, above the Mingoes, De Laet, m.; Axion, Evelin, 1., about Burlington; possibly modifications of the same name.

Amarongs, above Atrions; De Laet, m.

Rankokas (or Chichequaas, or Lamikas); Ramcocks; probably on the Rankokas Creek; De Laet, m.; Acrelius, m.; Evelin, 1. ("about four miles south of Burlington"), Proud, m.

Mantas[2], about Burlington; Acrelius, m.; Campanius, m., Smith, 1.; Mattikongees, "above Atrions" (possibly the same with Mantas), De Laet, m.

Calcefars, above the "Axions," Evelin—possibly above Burlington.

Sanhicans, Sanhigans, near Trenton; N. Vischer's and Reinier's maps; De Laet, m.; Ruttenber, m.[3]

[1] Proud mentions "Narraticons" on the north side of the Raritan River.

[2] "The Mantas dwelt hard by Matiniconk" (Burlington Island), Brown's narrative in S. Smith's Hist. of New Jersey, pp. 100, 136. Campanius (*op. cit.*, p. 49) mentions that the part about Trakonick Creek is inhabited by the Manteese Indians, but it is uncertain to which creek and which branch of the Indians these names apply. For according to Brinton (Lenape, p. 45), "mante" and the allied terms are synonymous with Minsi and show an extension of the subtribe.

[3] The maps of Nicholas Vischer and Reinier-Ottens, place one branch of the Indians with the name of Sanhicans along and north of the Raritan, and another in the neighborhood of Trenton. On the map of N. J. Vischer of 1655 this latter branch of Sanhicans is not indicated. According to Acrelius, the Falls of Trenton were called, at the time of the purchase of the land by the Swedes, "Santican" by the Indians. Brinton believes (Lenape, p. 43) that the Sanhicans extend from near New York Bay to the Delaware shore at the Falls, and were undoubtedly Lenape.

Mosilians, at the Falls of the Delaware, Evelin; may have been identical with either the Sanhicans or Assunpinks.

Assinpinks, Assunpinks, probably on the Assunpink Creek, at or near Trenton; Acrelius, m.; Proud, m.; Calcefars, Mosilians (at the Falls), Evelin, l.

Minnesinks, above the forks of the Delaware River; Acrelius, l., Proud, l.

As to the natives in the immediate vicinity of the Falls of the Delaware or on the site of the present town of Trenton, we find a further interesting note in Yates & Moulton (Hist. of N. Y., p. 225), who quote from a Heckewelder manuscript.[1] The Delawares say, according to Heckewelder, that "Chichohacki" was "a place on the east side of the Delaware River above Philadelphia, at or near a great bend, where the white people have since built a town, which they call Trenton. Their old town was on a high bluff, which was always tumbling down; wherefore the town was called Chichohacki which is, the tumbling banks, or falling banks." Captain John Smith on his map (1609) located "Chikahokin" near where Wilmington now stands (Brinton). Loskiel[2] mentions that the Delawares lived "about Trenton," but does not enter into any particulars. The local historians of Trenton have thus far largely avoided the question as to the predecessors of the whites in that location.

Having shown the distribution of the Lenape in the Delaware Valley, including the region from which came the osteological material to be here described, it would be very desirable if, before proceeding with the description, we could adduce a few historical notes as to the length of the time the Lenape were settled in that valley, and as to any possible predecessors of the Lenape in that region.

The Lenape did not consider themselves autochthonous to the country in which they were found by the first Europeans; on the contrary, they preserved a comparatively clear tradition of a not very remote immigration of the tribe into those

[1] Heckewelder's Communication to Dr. Miller, 1800; among the MSS. of the New York Historical Society; see also Mickle, Reminiscences of Old Gloucester, p. 1.

[2] Mission of the United Brethren among the Indians, London 1794, I, p. 124.

FIG. 4. Map showing the distribution of the Indians in the Valley of the Delaware River and the neighboring country on the arrival of the whites. (Drawn by the author.)

regions. Two separate and independent versions of this tradition were preserved to us by Heckewelder [1] and by Rafinesque, according to Brinton.[2] According to these traditions the Lenape lived originally in a distant country, west or northwest, and much beyond the "Namaesi Sipu." [3] From some cause they undertook a long migration eastward. A part of the tribe, together with the Mengwe, crossed the "Namaesi Sipu," conquered the "Alligevi," settled in towns to the east of the river, and for a long period occupied their and the adjacent country, the Lenape living to the south of the Mengwe. The Lenape huntsmen eventually discovered the Susquehanna, and then the ocean, the Delaware and Hudson Rivers. Returning, they reported the land to be without enemies, and emigration of a part of the tribe into the new-found territory soon followed. The absence of enemies or "snakes" is stated in both Heckewelder's narrative and Rafinesque's Wallam Olum; nor is there even the slightest allusion in either of the traditions of further Lenape history to any inhabitants of the country not enemies, or to any neighboring tribes. Furthermore, there is no sign that the Lenape language in New Jersey has undergone any marked modification, which would be very liable to happen had they joined some indigenous tribe. These circumstances make possible but one conclusion, which is, that the territory between the Susquehanna and Hudson and from the heads of these rivers to the sea, at the time of the Lenape emigration into the same, was not peopled.

The date of the arrival of the Lenape in the Delaware Valley can be grossly computed from the Wallam Olum, *i. e.*, from the number of chiefs reported in that record as having lived in the country from its occupation by the Lenape to the advent of the whites. According to H. C. Mercer,[4] "if we give twenty years to a chief's reign, the date of the first

[1] Hist., Manners and Customs of the Indian Nations, Phila., 1819, Mem. of the Hist. Soc. of Penn., XII, 1876, p. 47 *et seq.*

[2] C. S. Rafinesque MS., 1833; Brinton, The Lenâpé, Phila., 1885, p. 162 *et seq.*

[3] Generally, and to all appearances correctly, taken for Mississippi. Brinton, in his peculiar interpretation of the Wallam Olum of Rafinesque, thinks that the river meant by "Namaesi Sipu" may have been the St. Lawrence (*op. cit.*, p. 165), or even the Delaware (p. 37); it is difficult to discover anything in the legends as reported to justify any such opinion.

[4] An Ancient Argillite Quarry and Indian Village Site on the Delaware, p. 6.

coming of the Lenape would have been about 1387. This agrees fairly with what a Lenape told the Rev. Charles Beatty in 1767.[1] When counting beads on a wampum belt as years, according to tribal custom, he said that his people had come to the Delaware 370 years before, or in 1397." These data are scanty enough, nevertheless their agreement may be of some significance.

When the Lenape arrived in the Delaware Valley, they must have been in a more or less advanced stage of their arts and industries; they were the victors over the Alligevi, have occupied their country, and associated with the Mengwe. The Lenape have not evolved, though they may have improved, their arts and industries in New Jersey. Judging from this and the in no way extraordinary stage of culture of the tribe at the arrival of the Europeans, we ought to find in the Delaware Valley signs of a prolonged Indian industry of a fairly uniform character. If we take furthermore into consideration the uninhabited state of the country in which the Lenape arrived, and the absence of indications of any great racial admixture in the tribe during its migrations, we may also expect to find in the valley the remains of a fairly uniform physical type of people.

The questions arising from the actual finds concerning the native industry in the Delaware Valley belong to Archæology, and will be not here touched upon, nor allowed in any way to influence this paper.

As to the physical type of people in the valley, the above assumption is largely realized. The material at hand shows, with some exceptions, a considerable uniformity. The crania belonging to this prevalent type approach closely those of Lenape and may be safely considered as having belonged to individuals of that tribe.

But, among the specimens I have examined, there are at least two crania of a widely different type from any of the others. They are of a type which not only is unique in the regions ever occupied by the Lenape, but one of which I have

[1] Charles Beatty, Journal of a Two Months' Tour West of the Alleghany Mountains. London, 1868, p. 27.

as yet found no counterpart among American crania. These skulls can not be considered as individual deviations from any of the known eastern types and must be kept apart for further identification. The specimens are the "Burlington County" and "Riverview" crania. They were found in locations twelve and a half miles apart, and the first was discovered twenty years before the second, in an accidental way, by a different individual. One of the skulls is that of a male, the other that of a female, both of adult, yet not very aged individuals, both well developed and free from conditions that might be the causes of pronounced deformity, and free from all artificial deformation. Both skulls are much alike in their distinctive features, which fact very much strengthens the probability of their belonging to a different racial type from that of the Lenape. These features will be shown in the measurements and descriptions.

Description and Measurements of Crania.

Description of the Lenape Skulls and Allied Specimens Collected by Mr. Volk (Pll. I–IX).

The majority of the crania of these two series (considering the American and Peabody Museums' parts of the collection as one) are those of females. A considerable number of the specimens are in a more or less imperfect or fragmentary condition, nevertheless the material permits a fairly satisfactory description as well as a quite good series of measurements.

Almost all the crania from both sources are of a rather small or moderate size. Two of them (57785, 57793, Peabody Museum) show a slight artificial occipital compression, none any pathological deformity. The bones in the specimens collected by Mr. Volk are in various stages of preservation, but mostly very fragile; one calvarium shows some superficial fine scaling. On none of the skulls examined have there been found any stains of copper or pigment.

The majority of skulls of the two series here considered are distinctly of one clear type. Besides these there are several

crania among those collected by Mr. Volk (57783, '85, '87, '89, '93, Peabody Museum) which differ from the others mainly in the relative length and width. The crania of the prevalent type show a moderate to extreme dolichocephaly, while the exceptional specimens are moderately to quite markedly brachycephalic. It is an interesting circumstance that all these relatively short and broad skulls are those of males; another peculiar feature is their frequency in the region about Trenton. These facts make it probable that the brachycephalic skulls belong to Indians of a somewhat different physical type from that of the Algonquins which include the Lenape. Such a type, our collections show us, was common in prehistoric and possibly early historic times in the west and particularly the southwest of New Jersey. The frequency of the relatively short and broad male skulls about Trenton, unless accidental, may be the result of a fight in this location, one of the contending parties in which belonged to a brachycephalic people. It is not due to a local conquest, for in that case we should also find at least a certain proportion, if not a preponderance, of brachycephalic females. Marriages of strangers into a tribe or an adoption of captives will introduce new physical types, but in cases of that nature the new type remains usually an exception and a comparative rarity both among the living and skeletons. Further explorations about Trenton will undoubtedly aid us in deciding the question.

Description of the Dolichocephalic Skulls.—The crania of this type are generally of a fair hight. The face and nasal aperture are comparatively narrow, the orbits small and *rather low.*

Not one of the skulls is above the average in weight or thickness.

All the crania show a pronounced alveolar and moderate facial prognathism.

The lower jaw, where preserved, is quite high, but not very angular or massive; the chin is usually moderately prominent.

The dental arches are generally regular, the teeth of medium size, ordinary form, and often more or less worn off. No

dental anomalies were found. The palates are mostly parabolic in form, regular, and quite, though never excessively, spacious.

The nasal aperture is generally pyriform, its lower border less sharp than in whites; in one of six female crania there are moderate prenasal gutters, in two, moderate fossæ. The spine is in the mean less pronounced than in the whites, but it varies; the nasal bridge is of ordinary width and but a moderate hight, nasion depression in the females shallow, in the males submedium to quite marked.

The infraorbital fossæ are in some cases shallow, in others well pronounced. The malars are never very prominent, the zygomæ seldom more than moderately strong and expanded.

The orbits approach mostly the rectangular form; their borders are usually quite sharp. The interorbital septum varies from 2.2 to 2.4 cm. in the females; it measured 2.65 cm. in one of the male skulls.

The glabella is generally moderate, more or less convex. The supraorbital ridges are developed mainly, and in the females only, in their median portions, near the glabella; in this location they are usually fairly well marked in the female crania. They were very pronounced in one of the male specimens examined, and moderate to well developed in the others.

The forehead is generally of a moderate hight and fairly well arched; where, however, the glabella and supraorbital ridges are more pronounced, the forehead tends more or less to slope backward. The diameter frontal minimum varied in the specimens measured by me from 8.2 to 9.5 cm., the diameter frontal maximum from 10.4 to 11.7 cm., the nasion-bregma arc from 11.4 to 13.4 cm. (or 33.7 to 37.3 per cent. of the total arc from nasion to opisthion).

The sagittal region shows mostly a slight, occasionally a marked elevation. The parietal bones in the females are rather small, but well defined; they are larger, but not very prominent, in the males. The temporal ridges pass mostly slightly under the middle of the parietal bones; in a few instances they reach the middle or slightly above.

The temporo-parietal regions of the dolichocephalic skulls are generally more or less flat; the occiput varies from a medium to a considerable prominence, the more prominent forms preponderating.

The bregma-lambda arc was found to measure from 11.3 to 13.3 cm., the lambda-opisthion arc from 10.2 to 11.9 cm. (respectively from 31.7 to 37.3, and from 28.9 to 31.9 per cent. of the total arc from nasion to opisthion).

The base could be well examined in only a few instances. The foramen magnum is generally of a moderate size (diameter antero-posterior, in 3 cases, 3.5–3.7 cm.; diameter lateral maximum, in 5 cases, 2.8–3.25 cm.). The plane of the foramen is somewhat less inclined forward than in the whites; prolonged forward, it is met, at right angles, by a line from the nasion, from 2.5 to 4.0 cm. below the same.[1] Of the two jugular foramina, one, mostly the right, is usually larger than the other. The styloids, where preserved (four cases), were generally more or less slender and ranging in length from 0.5 to 3.0 cm. The petrous portions are generally at or slightly below the level of the surrounding parts of the base, and not sunken within these as in whites. The middle lacerated foramina are of submedium to small size, never attaining the size common in whites.[2] The glenoid fossæ are generally well proportioned.

The sutures in most of the crania of this series show a rather simple serration. Obliteration, where it could well be observed, was distributed as follows:

Skull No. 225, Field Columbian Museum: synostosis in the coronal suture, on both sides but more on the left, below the crossing of the suture by the temporal ridges.

Skull No. 227, Field Columbian Museum: in most of the coronal and parts of the sagittal suture.

Skull No. 228, Field Columbian Museum: in coronal suture below the ridges; also in parts of the sagittal, lambdoid, and left temporo-occipital sutures.

Skull No. 2, collected by Volk, now in the American Museum

[1] In the whites, the plane reaches in most cases from 2.0 to 3.5 cm. below the nasion. See also Topinard, Élem. d'Anthrop., 1885, p. 811 *et seq.*

[2] Concerning these characters see Science, Feb. 22, 1901, p. 309.

of Natural History: in whole coronal and the anterior half of sagittal suture; (lambdoid suture damaged).

Skull No. 6, collected by Volk, now in the American Museum of Natural History: in most of coronal, whole sagittal and superior two thirds of lambdoid suture.

Apparently the coronal suture participates in the ossification as early, if not earlier, than the sagittal, and in advance of the lambdoid suture.

The pterions are in all cases of the H form (spheno-parietal articulation), but mostly quite narrow.

Wormian bones are rather scarce. In four out of nine specimens that can be thoroughly examined for this purpose there are no Wormian bones at all: of the remaining, in No. 225 there are but two small Wormians in the lambdoid and one in the masto-squamous notch on the right side; in No. 226, one Wormian bone of a moderate size in lambda, one smaller in each temporo-occipital suture, and two small ones in the left squamo-mastoid angle; in No. 228, one small Wormian in each asterion; in 2, a small epipteric bone on the left side; and in 8 three small Wormians in the lambdoid suture.

The parietal foramina are both absent in 3 out of 9 cases where it is possible to examine for them; there is but one present in four cases, and both present in two instances. With one slight exception the foramina are all small. The retro-mastoid foramina, also, are in most of the skulls small.

Notes on the Brachycephalic Skulls.—All these crania show a good hight, rather superior than inferior to that of the dolichocephals. Two of the specimens, as mentioned before, show a slight degree of occipital compression; the narrower Algonquin crania are generally free from this deformity. The occiput in the undeformed specimens is quite round, the temporo-parietal regions full. The facial parts are mostly broken and not fit for any comparison. Each of the better-preserved skulls shows one to several small to moderate-sized Wormians; No. 57793, Peabody Museum, has a large, rounded bregma bone (3.5 cm. x nearly 3.5 cm.). Thickness and weight of bones normal.

A comparison of the here described Lenape (Field Columbian

Museum) skulls and those of similar type collected by Volk, with crania from various localities in the States of New York and Massachusetts that have been occupied by tribes other than the Iroquois, shows a considerable general agreement among all in both the form and measurements. All these tribes belonged apparently to one and the same physical Indian type, characterized by dolichocephaly, rather a narrow face, mesoseme to microseme orbits, mesorhyny and meso- to prognathism). With additional material it ought to be easy to define this type precisely, and once clearly established we shall be able gradually to trace not only its whole distribution, but possibly also its earlier location on this continent. The admixture of the short-headed element was apparently small, except perhaps in the Trenton district, and can be quite easily separated. (For detail measurements of the skull see tables.)

Description of the Bones from the "Deep Burials" on Dr. Abbott's Farm. — The lot consists of parts of at least five skeletons; many of the bones are badly decayed and others are broken. There are six pieces of skulls, besides some smaller fragments, belonging probably to five crania. No one of the pieces is large enough to afford any measurements or any definite conception as to the original size or shape of the skulls. Three of the pieces appear to have belonged to masculine and rather broad crania; a fourth piece is a small, narrow parietal, that apparently formed a part of a relatively longer and narrower feminine skull; a fifth piece is a portion of a parietal which also may have belonged to a narrow skull; the sixth piece allows of no conjecture. Taking into consideration the small size of the pieces and the possibility of some warping, all further conclusions drawn from their appearance would be largely guesswork without much value. The majority of the pieces of the long bones show that these belonged to rather strong individuals of a good stature. The femora show a pronounced flattening of the shaft near the upper extremity, and in this as well as other characters they equal the Lenape femora (see Table of Measurements and Notes on Long Bones).

The piece of frontal bone which Dr. Abbott reported as found in the gravels, and which is now in the Peabody Museum (No. 47865), is well preserved, though apparently very largely devoid of organic matter. The bone shows a pronounced yellowish and reddish discoloration, such as was noticed on the fragment of parietal bone found by Volk on a recent talus of gravel, but on no other crania or bones described in this paper. The surfaces of the bone show a little scaling, but no injury; the borders of the fractures, however, are in places somewhat obtuse, and a part of the coronal border shows some rubbing, with a few remaining striæ. Morphologically the bone is not very instructive. It was certainly a small frontal, with a low and somewhat sloping forehead, but there are very similar frontal bones in some of our quite recent Indian crania. The supraorbital ridges were of a medium prominence and developed mainly near the glabella. Thickness of the bone varies from five to six millimeters, which is nothing unusual.

The fragment of lower jaw found by Dr. Abbott in the gravels in the railway cut shows an inclination to massiveness and a prominent chin. The piece of a temporal bone found by Dr. Abbott in the same location presents nothing extraordinary; the mastoid is of a medium size. Both these pieces show blunt edges and some minor injuries. The discoloration is darker than in the above-described portion of the frontal bone and more grayish than yellow.

The tooth found by Dr. Abbott "in the gravels" is an ordinary human third molar, of a moderate size and with two roots, almost wholly united. The enamel is not cracked or vitreous. The dentine is of a straw-yellowish color, sound, and showing a considerable polish. The roots were artificially bevelled into the form of a quadrilateral pyramid. If this tooth is ancient, it must have been embedded in some matrix exceedingly favorable for its preservation.

In finds of the nature of those just described, unless, as can hardly be expected with small pieces of bone, they present some very remarkable indication of zoölogical inferiority or superiority, somatology must of necessity take a

secondary place and be only supplementary to careful geological observations.

Description of the "Gasometer" Skull (No. 14635, Peabody Museum, Pll. X–XIII). — This specimen is remarkable on account of its small size, an unusual thickness of the bones composing its vault, and a number of characters indicating rather an inferior development. The cranium is that of a female in advanced adult life. The face and the left side are much injured, nevertheless it can be seen that the whole skull was symmetrical and without any deformity.

The surface of the skull shows a number of small depressions, such as could be produced by moderate knocks, and on the frontal and occipital bones some scaling off of the external layer of the bone has taken place. There are no scratches or larger contusions. The structures of the base are very well preserved with the exception of the basilar process, which is separated from the sphenoid by a fracture. There is no lower maxilla. Of the superior maxilla only portions of the walls of the antra remain: the nasal and malar bones are lost almost entirely. All the breaks are quite sharp and appear fresh. The cells of the ethmoid are largely exposed and their thin walls are well preserved. One of the cells is filled with gray earth, and traces of the same are found in other locations. On each temporal (above the zygoma root on the right, above and behind the mastoid on the left), and on the left parietal, near the parietal foramen, is found a small greenish spot, looking like a copper stain.

The remaining parts of the face show that this was not very high or broad. The orbits were of a high mesoseme or a low megaseme index and of an ordinary depth (4.3 cm.). The orbital borders are sharp. The interorbital distance is unusually great, namely 2.75 cm., or 28.8 per cent. of the diameter between the malo-frontal sutures on the orbital border. The nasal bones were apparently somewhat thickened. Nasion depression shallow. Naso-frontal suture in a state of advanced obliteration. Glabella moderate ; supra-orbital ridges only near glabella, small.

The forehead is low, but not sloping, and uniformly con-

vex. The nasion-bregma arc measures 11.95 cm. (33.7 per cent. of the nasion-opisthion arc), the diameter frontal minimum 9.4 cm., the diameter frontal maximum near 11.3 cm.

The parietal and occipital bones show but moderate bulging. The temporal ridges are very well marked, more so than in any of the other crania examined. The upper boundary of the ridges reaches on each side nearly to the middle of the parietal. The occipital ridges and depressions are also unusually well marked for a female cranium. The pterions are in the form of a narrow H and are very near the posterior orbital walls (small extent of the frontal bone). Parietal foramina, one on each side, of ordinary size and location. Bregma-lambda arc 12.7, lambda-opisthion 10.85 cm. (respectively 35.8 and 30.6 per cent. of the whole arc from nasion to opisthion).

The temporal regions are quite flat. The zygomæ were apparently of a fair strength, though not massive. The mastoids are above the average in size and strength for a female, though not up to the average of those in males.

The sutures show an extremely simple serration, not equalled, though approached, in the other skulls examined. Most of the coronal and the whole sagittal suture are obliterated, but there are only traces of ossification in the lambdoid and temporo-occipital sutures, and none in the temporo-parietal and spheno-temporal articulations. There are no Wormian bones.

The thickness of the parietal bones ranges from 8.5 to 9.5 millimeters; the frontal bone is slightly thicker, the occipital bone, except in the median line, slightly thinner. Both the compact and cancellous layers are well preserved and seem to share proportionately in the thickening. There is no osteoporosis, nor any condensation of the bone. The weight of the skull is not excessive (15¼ oz. or 432 grams).

The ventral surface of the skull shows but a few impressions of the brain convolutions; this feature is common in Indian crania. The anterior clinoids are stout; the sella turcica is quite large, but appears normal. Dorsum sellæ broken; on

its base, in the middle, is a 7 mm. long and 4 mm. high, sharp elevation.

The base of the skull shows no deformity and its structures show but very little, if any, thickening, or effects of the same. All the foramina are rather submedium in size, a feature found not infrequently in individuals of small stature. The foramen magnum is of a regular, somewhat lozenge-shaped outline; its antero-posterior diameter is 3.2, maximum lateral diameter 2.55 centimeters. The plane of the foramen is somewhat more inclined backwards than in whites; a line from the nasion meets a prolongation of the plane forward, at right angle, 3.45 cm. below that point. The styloids, as well as the vaginal and spinous processes, are fairly well developed and preserved. Glenoid fossæ of ordinary dimensions. Petrous portions of the temporal bones are on a level with the surrounding parts, and the middle lacerated foramina are very small—both characters of an inferior cranial development. We find on each side an incomplete pterygo-spinous foramen. The pharyngeal tubercle is well marked. There is no sinking in of the base around the foramen magnum.

To diagnose the exact ethnic character of this specimen is a problem full of difficulties. In the first place, it is the cranium of a female, the sex in which the racial differences are generally less pronounced than they are in the males; in the second place, the skull can hardly be considered a normal one, which must of necessity add to the uncertainty of its classification. All that may be said positively is that in its general form, as well as in its main measurements and indices (*q.v.*), the "gasometer" skull approaches much more the crania of the Lenape than it does those from Burlington County and Riverview Cemetery; in fact it has nothing in common with these latter. The numerous exceptional characteristics which the "gasometer" skull shows, such as its low capacity, thick walls, small frontal region, large interorbital space, etc., are all well within the scope of individual variation and of themselves of but little racial significance. It seems to me equally impossible to positively declare that the skull either is or is not a Lenape skull; the main part of the

craniological evidence, however, favors more the former than the latter assumption. (Compare figs. 1 and 2, Pl. XXII.)

Description of the Burlington County Skull (No. 19513, Peabody Museum; Pll. XIV–XVII).—This cranium is that of a female, fully adult but not very advanced in age. The skull is very symmetrical, and in no way deformed or diseased. The bones are thin, but of considerable hardness. A slight warping causes a partial opening of the right coronal and temporo-sphenoidal sutures. The bones apparently retain some animal matter. Their surface has suffered a considerable scaling off, but as yet the diploë is not visible. The facial parts are much damaged, the superior maxilla being almost entirely absent. The mastoids are broken and the bone above them, particularly on the left side, shows numerous perforations; there is, however, no indication that these latter are pathological. The lower part of the occiput is damaged, and the sphenoid body broken across in front of the basilo-sphenoid articulation, but these injuries have not affected the form of the skull. There is no unnatural depression of the region about the foramen magnum. The right squama shows a small perforation, probably a recent injury; the bone exposed is almost throughout scaly. There are no scratches now visible on the surface of the skull, but such may have existed and disappeared with the outermost layer of the bones. There are no discolorations with the exception of a peculiar, narrow, regular band, lighter than the neighboring bone, that obliquely encircles the whole cranium. It seems that some narrow, firm band had been tightly applied to the head or skull and there left its impression.

The skull has very marked peculiarities of form, visible at the first sight. It is unusually low throughout its whole extent; the outlines of its planes are rounded, not angular; and the portion of the specimen behind a vertical plane passing through the auditory meati exceeds quite markedly the portion anterior to the same.

Of the face enough is left to show that it was very narrow, and the malars, both preserved, are even less prominent than

those which we find in an average white female skull. The orbits are megaseme, their borders quite sharp, their angles rounded; depth 4.0 cm. The nasal bridge, well preserved, is of a fair hight, slightly concave in its upper half, and not very broad. Nasion depression moderate. Glabella large, of medium convexity. There are no supraorbital ridges proper, but we find an elevation on each side of and adjoining the glabella. The interorbital septum measures 2.4 cm. (24.6 per cent. of the line between the orbital ends of the malo-frontal sutures).

The forehead is very low, though not sloping. Diameter frontal minimum 9.3, frontal maximum 11.6 cm.; nasion-bregma arc 11.6 cm. (33.2 per cent. of the total arc from the nasion to opisthion).

The parietals show considerable, quite uniform convexity from above downward and slightly less so from before backward. The sagittal region is but very slightly elevated. The bregma-lambda arc measures 11.8 cm. (33.8 per cent. of the arc from the nasion to opisthion). There is only one parietal foramen (right), of moderate size. Temporal ridges were not high and are almost totally imperceptible.

The occipital region is quite full and not protruding; the right side is very little more prominent than the left. Occipital ridges and depressions very faint.

The temporal regions show a moderate bulging. The squamæ are low. The zygomæ are quite slender.

Pterions of H form, rather narrow.

The sutures show as yet no traces of ossification. Their serration is superior to that in any of the Lenape skulls. A distinct serration is seen in the posterior third of the temporo-parietal sutures, which is uncommon. There are no Wormian bones.

The base of the skull is rather flat. The foramen magnum is quite large, measuring 3.8 cm. in its antero-posterior and about 2.9 cm. in its maximum lateral diameter. The plane of the opening, if extended forward, would pass only about one centimeter beneath the nasion. The processes are low, the foramina of moderate size except the foramina ovale, which are smaller than average in female crania. The styloids are

broken; they were, particularly the left, very slender. The glenoid fossæ are of a fair depth, the right being slightly more spacious than the left.

The ventral surface of the skull shows but a few and shallow impressions of the convolutions; it is scaling off similarly to the outer surface. Thickness of the left parietal 3 to 4 millimeters.

The differences between this specimen and the various Lenape and eastern crania, as shown by the inspection, are even more plainly indicated by the principal measurements and indices (see tables). The most characteristic features of the specimen are its considerable breadth coupled with excessive narrowness of the face; its extremely small hight, which is visible even if we compare the auriculo-bregmatic instead of the basi-bregmatic hights, and which gives rise to very low hight-length and hight-breadth indices; and the megaseme character of its orbits. Differences of such a nature and so many in number are totally beyond the scope of individual variation. When found in a normal skull they can only represent racial features. In this case they effectually separate the Burlington County cranium from all those described before in this paper.

Description of the Riverview Cemetery Skull (No. 44280, Peabody Museum; Pll. XVIII–XXI).—The cranium is that of a male about fifty years of age. It is somewhat damaged, but fortunately enough is preserved of the face as well as the vault for almost all the more important measurements. The skull is normal with the following exceptions: there is a slight depression backward of the left lower portion of the face, and the angle between the plane of the posterior nares and the basilar process is somewhat more acute than usual; the left border of the foramen magnum is somewhat irregular; and on the left side the upper half of the border of the occipital is situated somewhat higher than that of the parietal bone. The left mastoid is also situated a little more posteriorly than the right, all of which shows some disturbance in the development of the inferior portion of the left side of the skull. These defects, however, have not been of a serious enough

character to affect the general conformation of the skull, and the vault as well as other parts are symmetrical.

The surface of the skull shows a large abrasion on the left parietal and several cuts, such as could be made with the edge of a not very sharp shovel, on the left parietal bone; a considerable and deep scaling, particularly over the frontal and left parietal regions; and two dark and greenish discolorations of oval shape about 2.0 cm. in the longer diameter, situated one on the left squama behind the pterion and one near the middle of the right squama and on the parietal bone adjoining. Both squamæ and the occipital bone show deficiencies caused by injuries.

Inspection as well as measurements show the Riverview skull to be very closely allied to that from Burlington County and with this to differ radically from all those described in this paper. The Riverview skull presents similar rounded outlines of its planes, similar low hight, narrow face, and megaseme orbits, as that from Burlington County. The differences between the two are only slight and such as are commonly met with in the two sexes.[1]

The face in the Riverview skull is orthognathic, but this is undoubtedly due somewhat to the previously mentioned backward depression of the facial parts. The alveolar process, fairly well preserved, presents also but little slanting. The alveolar arch is regular and not massive; it is rather low (alveolar point to nasal border 1.85 cm.), but not very narrow (maximum external width 5.6 cm.). The alveoli of the second incisors and those of all the molars are largely obliterated. Judging from the size of the remaining alveoli, the teeth must have been of a rather submedium size; their number and position were normal. The palate is symmetrical and pre-

[1] The peculiar features of these crania were well recognized by Professor F. W. Putnam as early as 1888, and are also acknowledged by Dr. Russell in his paper on the Human Remains from the Trenton Gravels (pp. 148–150). Dr. Russell wrote under the difficulty of very insufficient material, which circumstance had undoubtedly influenced his final conclusions. Prof. Putnam's remarks, made after the presentation by Mr. Volk of the Riverview Cemetery specimen to the Peabody Museum, are as follows (Peab. Mus. Rep., v. IV, No. 2, 1888, p. 35): "This human skull (the Riverview specimen) is small, and of a remarkable form and agrees with two others (Burlington Co. and "Gasometer" skulls) which we have from New Jersey, one of which was certainly from the gravel. These three skulls are not of the Delaware Indian type and there is considerable evidence that they are crania of the palæolithic people of New Jersey."

sents nothing extraordinary; its length, from the alveolar point to the end of the spine (which is small) is 4.8 cm., its maximum width 4.1 cm., hight, in front of the first molars, where the bone has suffered but little change, 1.45 cm. Posterior nares regular, slightly wider near the palate than above; hight, in middle, 2.9, width, in middle, 2.6 cm.

The nasal aperture is regular, of a pyriform shape and with sharp borders; there are two small prenasal fossæ. The nasal index shows a low mesorhyny.

The suborbital fossæ are well marked. The molars are not massive and show no prominence, except directly above the just named fossæ.

The orbits are of moderate size and megaseme index; they approach the quadrangular shape; borders quite sharp, depth 4.4 cm., interorbital septum 2.65 cm. (27.5 per cent. of the line between the orbital ends of the malo-frontal sutures).

Nasal bridge slightly submedium in hight, moderately wide. Glabella quite prominent, and the same is true of the ridges, which extend above the median halves of the orbits.

The forehead is low, but not sloping. Above the supraorbital ridges the frontal bone shows a moderate depression, which in the present state of the specimen is accentuated by the scaling of the outer table of the bone. Frontal eminences ordinary. There is a persistence of the metopic suture. Diameter frontal minimum, 9.6, diameter frontal maximum 12.6 cm.; nasion-bregma arc 12.1 cm. (32.1 per cent. of the total nasion-opisthion arc).

The parietal bones show nothing unusual. The eminences are not prominent. Temporal ridges low, scarcely traceable. No parietal foramen. Bregma-lambda arc 14.0 cm. (36.8 per cent. of the nasion-opisthion arc), showing a considerable antero-posterior development of the bones.

The occipital bone shows on the left side above the superior ridge a moderate bulging, which produces the before mentioned somewhat greater elevation of the superior half of the occipital over the adjoining parietal border on that side. The superior occipital ridge and inion elevation are well marked.

The temporal regions show a moderate bulging. The

squamæ are quite low. The zygomæ were apparently of only moderate strength. Styloids masculine, not very massive.

Base of the skull: The foramen magnum is, as already stated, slightly irregular; its size is moderate (diameter antero-posterior 3.65, diameter lateral maximum 3.2 cm.). There is no depression of the bones about the foramen. The plane of the foramen, prolonged forward, passes 1.2 cm. beneath the nasion. The posterior condyloid foramina are obliterated; the remaining openings in the base present nothing unusual. The processes, including the styloids, are all well developed. The petrous portions are but slightly sunken below the level of the surrounding parts, the middle lacerated foramina are smaller than in average whites. Glenoid fossæ fairly deep.

The sutures of the skull show a fine, not very deep serration. Obliteration is noticeable only in the sagittal suture, at vertex and about obelion, and at a point in front of the pterion, on the left side in the coronal suture. The pterions are of the H form, but quite narrow. There are no Wormian bones.

Conclusions.

Although the material reported upon in this paper is not all that could be desired, nevertheless the examination of the same has brought out quite clearly a number of points, which can be briefly summarized as follows:

1. The bulk of the crania and bones from the Delaware Valley and Trenton are those of the Lenape.

2. The racial identity of the bones from the deep burials on Abbott's farm is uncertain, but they approach in several ways the bones of the Lenape.

3. The Abbott gravel finds (fragments) give no indication as to their racial character.

4. The Burlington County skull and that from the Riverview Cemetery at Trenton are both of a type which is totally different from that of the Lenape, or any other Indians from the East or elsewhere of which thus far we have any knowledge.

It is not my purpose to enter into a speculation as to the antiquity of these two skulls; the gathered facts permit,

nevertheless, a few simple logical deductions bearing upon this point. The skulls belong to another race than the Lenape or any of the eastern Indians,—of that there can be no possible doubt. They might be extraneous skulls, those of captives or visitors of the Lenape, but if we consider that supposition, we are totally unable to trace their descendance. Low crania occur only among the far distant Apache, but there the low hight is associated with a strong, broad face and other distinguishing features. If not intrusive, the crania must be those of a people that preceded the Lenape in the Delaware Valley. This last hypothesis would be greatly strengthened by any succeeding finds of crania of a similar character.

Should the existence of a pre-Lenape race in New Jersey become established as a fact, then can be approached the problem of the antiquity of such a race, a problem almost wholly one of geology.

It may be added that all the crania described in this paper differ widely from those of the Eskimo (nor can I recollect a single important somatological fact, from my investigations or those of others, which would support the theory of a prehistoric occupation of any of the eastern States below the St. Lawrence River by the Eskimo). Both the Lenape and the Burlington County and Riverview skulls are also easily differentiated from any skulls of the whites. Low crania are found among the Basques, but there is not the slightest trace in history of any of these people ever having lived in the Delaware Valley.

The detail measurements of the various crania treated of in this paper will be found in the following tables; and in order to facilitate the study of the region from which came the skulls here described from an *archæological* standpoint, I append a special bibliography.

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ton, L. I., A.M.N.H.			New York, No. 14114, Peabody Museum	New York, No. 38964. Peabody Mus.	Four from Massachussetts (Peabody Museum), Average	Sixteen from Massachusetts (Russell), Average	*Minima* of Preceding Measurements	*Maxima* of Preceding Measurements	"Gasometer" Skull, Trenton (No. 14,635, Peabody Mus.)	The Burlington Co. Skull, No. 19513, Peabody Museum
No. H	No. I	Average								
18.2	18.5	18.09	18.0	17.5	17.8	17.81	16.9	18.5	1070 c.c. 17.2	abt. 1275 c.c 17.7
13.35	13.9	13.34	13.4	13.55	13.28	13.45	12.1	13.9	abt. 13.2	*14.5*
13.3	13.35	13.09	12.45	13.45	13.3	13.45	12.45	13.5	12.3	*11.5*
73.4 73.1 99.6	75.1 72.2 96.0	73.7 72.4 98.1	74.4 68.9 92.9	77.4 76.9 99.3	74.6 74.9 100.2	74.8 75.9 100.0	66.1 68.9 89.9	80.8 79.4 108.0	abt. 76.7 71.5 abt. 93.2	*81.9* *65.0* *79.3*
6.6 12.5	6.9 13.3	6.9 12.87	? ?	7.2 ?	6.7 ?	? 12.74	6.2 11.9	7.2 13.75	? ?	? abt. *12.0*
52.8	51.9	?	?	?	?	?	48.8	56.3	?	?
2.87 3.6	3.47 3.9	3.22 3.75	3.35 3.85	3.25 3.65	3.37 4.0	3.68 3.92	2.87 3.6	3.7 4.25	? 3.6 R	3.5 3.7
79.8	89.0	86.0	87.0	89.0	84.2	86.3	79.7	92.5	?	*94.6*
4.5 2.35	5.1 2.35	4.85 2.38	4.85 2.7	5.0 2.7	4.87 2.52	5.1 2.58	4.5 2.2	5.2 2.65	? ?	? ?
52.2	46.1	49.1	55.7	54.0	51.8	50.6	45.1	56.7	?	?
10.0 9.8	? ?	? 9.97	9.6 9.3	10.1 10.5	9.8 9.7	9.53 9.26	9.2 9.26	10.5 10.5	? 9.3	? 9.5
102.0	?	?	103.2	96.2	101.0	102.9	95.2	104.0	?	?

CRANIAL MEASUREMENTS.

| | Lenape, Field Columb. Mus. | | | | Crania, Feminine, Lenape and Allied | | | |

y, A. M. N. H.	Port Washington, Long Isl., A. M. N. H.						New York, No. 38962, Peabody Mus.	New York, No. 38963, Peabody Mus.	*Minima* of Preceding Measurements.	*Maxima* of Preceding Measurements.	The Riverview Cemetery Skull, No. 44280, Peabody Mus.
	A.	B.	C.	D.	E.	Average.					
?	?	?	?	?	?	?	?	?	—	—	bet. 1300 & 1400 c. c.
.5	19.2	18.9	19.2	19.5	19.3	19.22	19.7	18.5	17.1	19.7	18.4
.7	13.8	13.2	13.1	14.2	13.0	13.46	14.2	13.9	13.0	14.6	*14.6*
?	14.4	14.5	?	14.6	13.8	14.32	14.1	14.5	13.7	14.6	*11.6*
.1	71.9	69.8	68.2	72.8	67.4	70.0	72.1	75.1	67.4	83.8	*79.3*
?	75.0	76.7	?	74.9	71.5	74.5	71.6	78.4	71.5	83.8	*63.0*
?	104.3	109.8	?	102.8	106.2	105.7	99.3	104.3	98.6	109.8	*79.5*
?	7.5	7.1	7.3	8.4	?	7.57	?	7.8	7.1	8.4	6.9
?	14.3	13.5	?	14.5	?	14.1	?	14.7	13.5	14.7	(near 12.1)
?	52.4	52.6	?	57.9	?	54.3	?	52.1	50.0	57.9	(near 57.0)
?	3.3	3.2	3.5	3.25	?	3.3	?	3.4	3.2	3.5	3.25
?	4.15	3.9	4.15	4.07	?	4.06	?	3.9	3.85	4.15	3.55
?	79.5	82.1	84.3	79.9	?	81.4	?	87.2	79.5	88.6	*91.6*
?	5.2	5.25	5.1	6.1	?	5.4	?	5.5	4.7	6.1	5.0
?	2.75	2.25	2.2	2.65	?	2.46	?	2.75	2.2	3.0	2.4
?	52.9	42.9	43.1	43.4	?	45.5	?	50.0	42.9	63.8	48.0
?	10.6	11.0	?	10.3	?	10.6	?	10.85	10.1	11.0	*7.9*
?	10.8	11.3	?	11.0	?	11.0	?	11.45	10.35	11.45	*7.0*
?	98.1	97.3	?	93.6	?	96.4	?	94.8	93.6	104.4	*92.9*

CRANIAL MEASUREMENTS.

	Crania, Masculine, Lenape and Allied.																																	
	No. 228 (Field Columbian M.) Lenape	Volk's Collection, Trenton No. 57783 Peabody Mus.	No. 57785 Peabody Mus.	No. 57786 Peabody Mus.	No. 57787 Peabody Mus.	No. 57788 Peabody Mus.	No. 57789 Peabody Mus.	No. 57791 Peabody Mus.	No. 57793 Peabody Mus.	Minimum	Maximum	Tottenville, Staten Isl. No. 20–3190, A. M. N. H.	Tottenville, Staten Isl. 20–3246, A. M. N. H.	Croton-on-Hudson, 20–2335, A. M. N. H.	Crugers (near Croton) 20–2433, A. M. N. H.	Astoria, Long Island, A. M. N. H.	Port Washington, Long Isl., A. M. N. H.						New York, No. 38962, Peabody Mus.	New York, No. 38963, Peabody Mus.	*Minima* of Preceding Measurements.	*Maxima* of Preceding Measurements.	The Riverview Cemetery Skull, No. 44280, Peabody Mus.
																	A.	B.	C.	D.	E.	Average.					
Capacity (Flower's Method)	abt. 1415 c.c.	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	—	—	bet. 1300 & 1400 c. c.
Diam. antero-posterior (glab.-occ.)	17.9	17.3	(17.3)	17.6	17.1	19.2	17.7	18.8	(17.3)	17.1	19.2																
Diam. lateral maximum	13.4	14.5	(14.9)	13.9	abt. 14.0	14.2	abt. 14.6	13.9	(15.5)	13.9	14.6	19.0	19.35	18.9	18.4	18.5	19.2	18.9	19.2	19.5	19.3	19.22	19.7	18.5	17.1	19.7	18.4
Hight (basion-bregma)	?	14.5	(14.8)	abt. 13.7	14.1	? (quite high)	? (q. high)	? (q. high)	? (q. high)	13.7	14.5	13.4 14.25	14.1 14.2	13.4 14.2	14.3 14.1	13.7 ?	13.8 14.4	13.2 14.5	13.1 ?	14.2 14.6	13.0 13.8	13.46 14.32	14.2 14.1	13.9 14.5	13.0 13.7	14.6 14.6	*14.6* *11.6*
Cephalic Index	74.9	83.8	Slight occipital compression	79.0	81.9	74.0	82.5	73.9	Slight occipital flattening probable	73.9	83.8	70.5	72.9	70.9	77.7	74.1	71.9	69.8	68.2	72.8	67.4	70.0	72.1	75.1	67.4	83.8	*70.3*
Hight-length Index	?	83.8		77.8	82.5	?	?	?		77.8	83.8	75.0	73.4	75.1	76.6	?	75.0	76.7	?	74.9	71.5	74.5	71.6	78.4	71.5	83.8	*63.0*
Hight-breadth Index	?	100.0		98.6	107.1	?	?	?		98.6	107.	106.3	100.7	106.0	98.6	?	104.3	109.8	?	102.8	106.2	105.7	99.3	104.3	98.6	109.8	*79.5*
Nasion-alveon hight	?	abt. 7.2	?	?	?	?	?	?	?	—	—	7.6	?	7.15	7.1	?	7.5	7.1	7.3	8.4	?	7.57	?	7.8	7.1	8.4	6.9
Diam. byzigomatic max	?	14.4	?	?	?	?	?	?	?	—	—	14.0	?	13.9	14.1	?	14.3	13.5	?	14.5	?	14.1	?	14.7	13.5	14.7	(near 12.1)
Facial Index	?	50.0	?	?	?	?	?	?	?	—	—	54.3	?	51.4	50.4	?	52.4	52.6	?	57.9	?	54.3	?	52.1	50.0	57.9	(near 57.0)
Orbital hight, average	?	3.4	?	?	?	?	?	?	?	—	—	3.3	?	3.2	3.5	?	3.3	3.2	3.5	3.25	?	3.3	?	3.4	3.2	3.5	3.25
Orbital breadth "	?	4.0	?	?	?	?	?	?	?	—	—	3.9	?	3.85	3.95	?	4.15	3.9	4.15	4.07	?	4.06	?	3.9	3.85	4.15	3.55
Orbital Index, "	?	85.0	?	?	?	?	?	?	?	—	?	84.6	?	83.1	88.6	?	79.5	82.1	84.3	79.9	?	81.4	?	87.2	70.5	88.6	*91.6*
Hight of Nasal Aperture	?	5.25	?	?	?	?	?	?	?	—	—	5.05	?	4.7	5.2	?	5.2	5.25	5.1	6.1	?	5.4	?	5.5	4.7	6.1	5.0
Breadth of " "	?	2.65	?	?	?	?	?	?	?	—	—	2.6	?	3.0	2.85	?	2.75	2.25	2.2	2.65	?	2.46	?	2.75	2.2	3.0	2.4
Nasal Index	?	50.5	?	?	?	?	?	?	?	—	?	51.5	?	63.8	54.8	?	52.9	42.9	43.1	43.4	?	45.5	?	50.0	42.9	63.8	48.0
Basion-alveon line	?	101	?	?	?	?	?	?	?	—	—	10.5	?	10.6	10.2	?	10.6	11.0	?	10.3	?	10.6	?	10.85	10.1	11.0	*7.9*
Basion-nasion line	?	10.35	?	?	?	?	?	?	?	—	—	11.1	10.5	10.15	10.7	?	10.8	11.3	?	11.0	?	11.0	?	11.45	10.35	11.45	*7.0*
Gnathic Index (Flower)	?	97.6	?	?	?	?	?	?	?	—	—	94.6	?	104.4	95.3	?	98.1	97.3	?	93.6	?	96.4	?	94.8	93.6	104.4	*92.9*

Femora

Side	Length	Diam. antero-posterior at middle	Diam. lateral at middle	Diam. antero-posterior at upper flattening, middle	Diam. lateral do	Index at middle	Perforation of Fossa
r.	45.1	2.55	2.35	2.05	3.15	71.8	present, large
l.	45.2	2.5	2.45	2.0	3.25	71.1	do, do
r.	40.9	2.3	2.25	2.1	3.0	73.0	—
l.	?	2.4	2.25	2.0	3.0	?	—
l.	?	2.5	2.45	2.25	3.3	71.1	?
r.	?	2.9	2.35	2.25	3.2	71.7	
						59.6	—
						68.9	?
						66.7	?
						69.4	—
r.	near 46.0	2.85	2.45	2.4	3.4	71.4	—
r.	?	3.05	3.1	?	3.4		—
r.	?	?	?	2.3	3.6	76.8	—
l.	?	?	?	2.2	3.7		
r.	?	2.85	2.55	2.4	3.4	68.5	
l.	?	?	?	2.65	3.45		
r.	?	?	?	2.15	3.35		
l.	?	?	?	2.2	3.5		

Tibiæ

Side	Length	Diam. antero-posterior at middle	Diam. lateral, do	Index at middle	Diam. antero-posterior at nutr. foramen	Length	Observations
r.	36.4	2.6	1.7	65.4	3.05	25.2	Bone slender
l.	?	2.85	1.75	61.4	3.1		
r.	?	2.55	1.8	70.6	3.15		
l.	34.9	?	?	?	2.8		
r.	?	?	?	?	3.8		
r.	?	3.1	1.7	54.8	3.4		
				62.6			
l.	?	2.6	1.85	75.0	3.35		
r.	?	?	?	?	?		
r.	?	3.25	2.15	66.2	?		

MEASUREMENTS OF AND NOTES ON LONG BONES.

Femora

	No.	Sex	Side	Length	Diam. antero-posterior at middle	Diam. lateral at middle	Diam. antero-posterior at upper flattening, middle	Diam. lateral do	Index of the upper flattening	Shape	Linea Aspera	Forward Bend of Shaft	Third Trochanter
I. Volk's Collection, the more superficial burials:	7.	Fem.	r.	45.1	2.55	2.35	2.05	3.15	65.1	nearly prismatic	quite marked	slight	—
	do	do	l.	45.2	2.5	2.45	2.0	3.25	61.5	prismatic	do	do	—
	2.	do	r.	40.9	2.3	2.25	2.1	3.0	70.0	do	moderate	do	moderate
	do	do	l.	?	2.4	2.25	2.0	3.0	66.7	do	do	do	?
	5.	do	l.	?	2.5	2.45	2.25	3.3	68.2	nearly prismatic	?	?	?
	11.	Male	r.	?	2.9	2.35	2.25	3.2	70.3	do	quite marked	moderate	?
	Average:								67.0				
II. Do, the deep burials (Abbott's Farm):	a.	Male	r.	near 46.0	2.85	2.45	2.4	3.4	70.6	nearly prismatic	pronounced	moderate	?
	b.	do	r.	?	3.05	3.1	?	3.4	?	not well defined	moderate	do	quite marked
	c.	do	r.	?	?	?	2.3	3.6	63.9	?	?	?	—
	c.	do	l.	?	?	?	2.2	3.7	59.5	?	?	?	quite marked
	d.	do	r.	?	2.85	2.55	2.4	3.4	70.6	prismatic	pronounced	?	—
	e.	do	l.	?	?	?	2.65	3.45	76.8	?	?	?	?
	f.	?	r.	?	?	?	2.15	3.35	64.2	nearly prismatic	moderate	?	?
	f.	?	l.	?	?	?	2.2	3.5	62.9	nearly round	do	?	?
	Average:								66.8				

Tibiæ

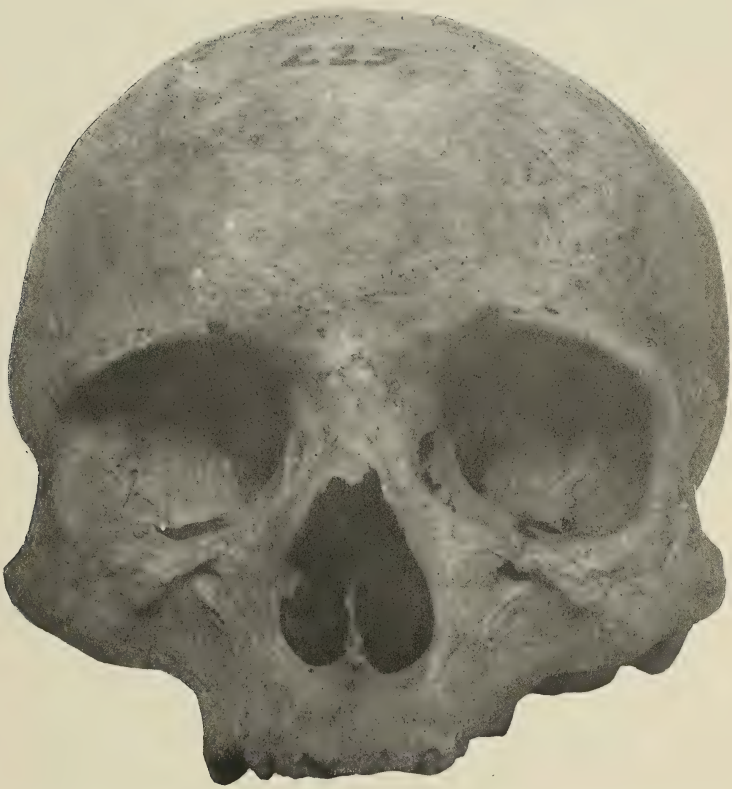
	No.	Sex	Side	Length	Diam. antero-posterior at middle	Diam. lateral, do	Index at middle	Diam. antero-posterior at nutr. foramen	Diam. lateral, do	Index at Nutritive Foramen	Shape	Observation
I.	7	Fem.	r.	36.4	2.6	1.7	65.4	3.05	1.8	59.0	Type 2 (prismatic, with posterior surface slanting outward)	Head shows ordinary inclination
	do	do	l.	?	2.85	1.75	61.4	3.1	1.75	56.5	2	———
	2	do	r.	?	2.55	1.8	70.6	3.15	2.05	65.1	shape indefinite	———
	do	do	l.	34.9	?	?	?	2.8	1.9	67.9	2	Moderate, fusiform, swelling at middle
	5	do	r.	?	?	?	?	3.8	1.95	51.3	?	———
	11	Male	r.	?	3.1	1.7	54.8	3.4	1.8	52.9	near 2	———
	Average:						62.6			58.3		
II.	α	?	l.	?	2.6	1.85	75.0	3.35	2.05	61.2	Type 2	———
	β	?	r.	?	?	?	?	?	?	?	2	———
	γ	Male	r.	?	3.25	2.15	66.2	?	?	?	4 (a ridge along the middle of the posterior surface	———

Humeri

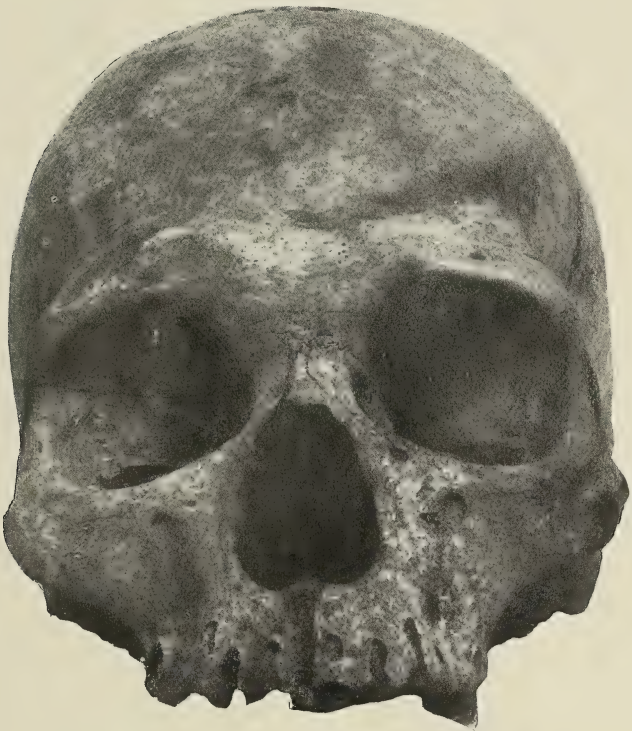
	No.	Sex	Side	Length	Diam. antero-posterior at middle	Diam. lateral do	Index at middle	Perforation of Fossa
I.	7	Fem.	r.	30.9	1.95	1.4	71.8	present, large
	do	do	l.	?	1.9	1.35	71.1	do, do
	2	do	r.	?	1.85	1.35	73.0	—
	do	do	l.	?	?	?	?	—
	11	Male	l.	?	1.9	1.35	71.1	?
	Average:						71.7	
II.	t.	?	r.	abt. 32.0	2.6	1.55	59.6	—
	u.	?	l.	?	2.25	1.55	68.9	?
	v.	Male	r.	?	2.4	1.6	66.7	?
	w.	do	r.	? not far from	2.45	1.7	69.4	—
	x.	Fem.	l.	32.0	2.1	1.5	71.4	—
	y.	?	l.	?	?	?	?	—
	z.	?	l.	?	2.15	1.65	76.8	—
	Average:						68.5	

Radii

	No.	Sex	Side	Length	Observations
II.	r.	?	l.	25.2	Bone slender



Lenape Skull (No. 225, Field Columbian Museum). Anterior View.



Lenape Skull (No. 226, Field Columbian Museum). Anterior View.

Lenape Skull (No. 226, Field Columbian Museum). Lateral View.

Lenape Skull (No. 227, Field Columbian Museum). Lateral View.

Lateral View of a Female Skull from the Low Lands, Trenton (A. M. N. H.).

Lateral View of a Male (?) Skull from the Low Lands, Trenton (Am. Mus. Nat. Hist.).

Lenape Skull (No. 225, Field Columbian Museum). Superior View.

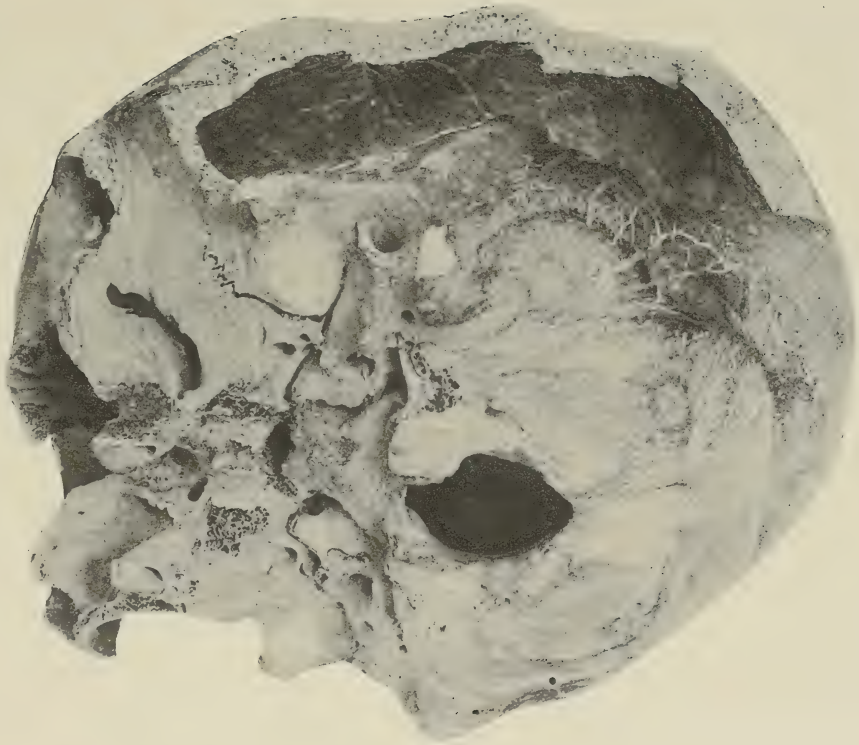
Lenape Skull (No. 227, Field Columbian Museum). Superior View.

A Pronounced Dolichocephalic Skull from the Low Lands, Trenton (Am. Mus. Nat. Hist.). Superior View.

"Gasometer" Skull (Peabody Museum). Anterior View.

"Gasometer" Skull (Peabody Museum). Lateral View.

"Gasometer" Skull (Peabody Museum). Superior View.

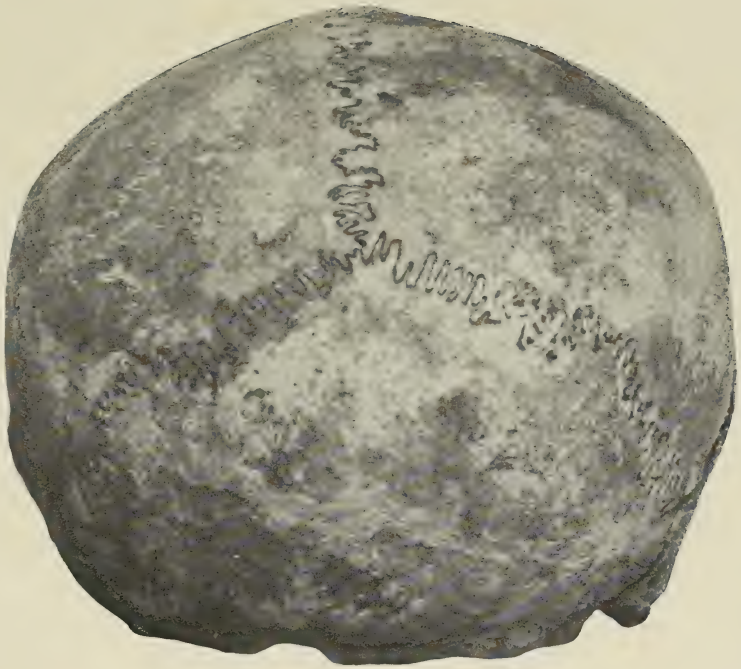


"Gasometer" Skull (Peabody Museum). View of the Base.

"Riverview Cemetery" Skull (Peabody Museum). Anterior View.

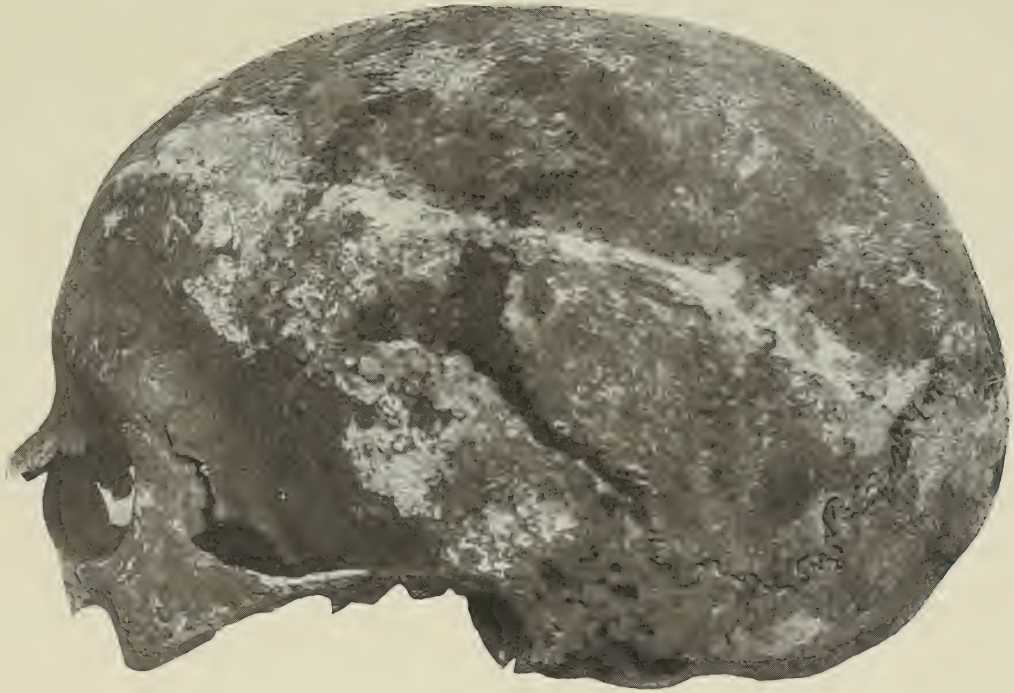
"Riverview Cemetery" Skull (Peabody Museum). Lateral View.

"Riverview Cemetery" Skull (Peabody Museum). Superior View.



"Burlington County" Skull (Peabody Museum). Posterior View.

"Burlington County" Skull (Peabody Museum). Anterior View.



"Burlington County" Skull (Peabody Museum). Lateral View.

"Burlington County" Skull (Peabody Museum). Superior View.

"Riverview Cemetery" Skull. Posterior View.

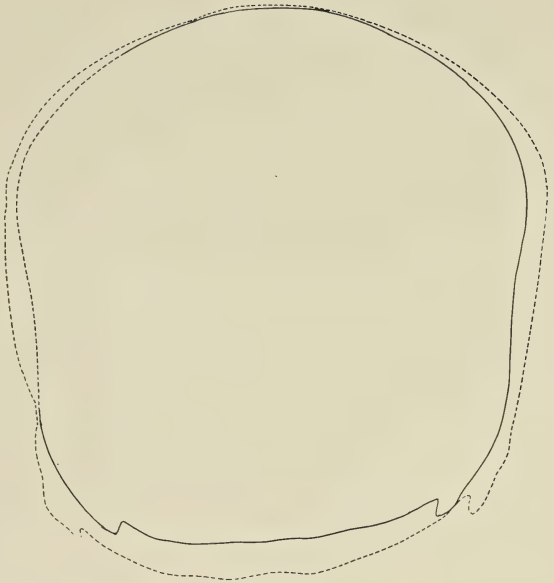


Fig. 1.—The Outlines of the Posterior Norma of the "Gasometer" (———) and a Lenape (. . . . .) Skull.

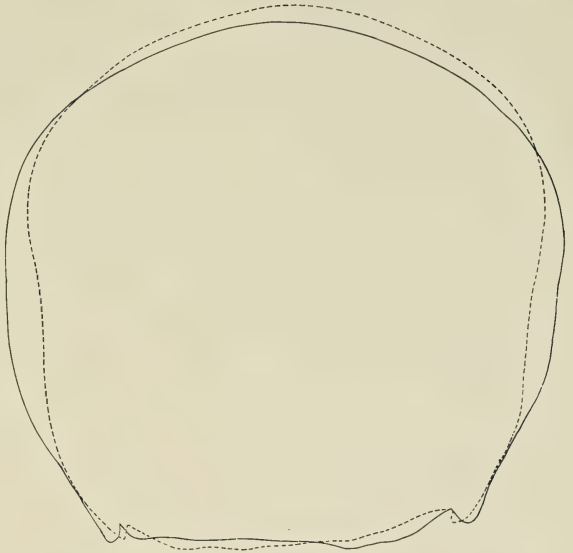


Fig. 2.—The Outlines of the Posterior Norma of the "Gasometer" (. . . . .) and the "Burlington County" (———) Skull.

Article IV.—DESCRIPTION OF A NEW FORM OF MYALINA FROM THE COAL MEASURES OF TEXAS.

By R. P. Whitfield.

Among some invertebrate fossils presented to the Museum in 1896 by Miss F. A. M. Hitchcock, Ph.D., there are several specimens of a *Myalina* so remarkably different from any known species of the genus that I venture to present it as a new form.

Shells of the genus *Myalina*, although quite abundant in the Coal Measures of the United States, are usually so monotonous in character, as regards their general form, that it is quite difficult to distinguish one species from another. There are about thirty species recognized in catalogues, but it is not easy to identify more than a few satisfactorily, unless one considers the localities and the different geological horizons at which they occur to be evidences of specific difference. The interior of the shell also presents the same monotonous features, even among the forms usually considered to be distinct species; at any rate, this may be stated of the American specimens.

In the original description of the genus, which was based upon Upper Carboniferous shells from Visé, Belgium, the valves are stated to be equal, and most of the authors who have considered the genus reiterate the statement, though McCoy, King, and a few others have distinctly stated that the opposite is the case. In the American shells the inequality of the valves is very pronounced. Another feature of the usual diagnosis is the assertion of the existence of an internal septum within the beak of one or both valves. This feature I have never found in any American specimen. There is sometimes seen in casts of *Myalina angulata* Meek & Worthen from the Chester Limestone horizon a horizontal slit beneath the beaks of specimens, where the substance of the shell has been quite thin. This results from the cavity of the beak extending under the cartilage area, but that area is external

and not internal, and consequently the slit is not from an internal septum, like that of *Septifer* or *Dreissena*, on which the anterior adductor muscle is situated. In our Myalinas

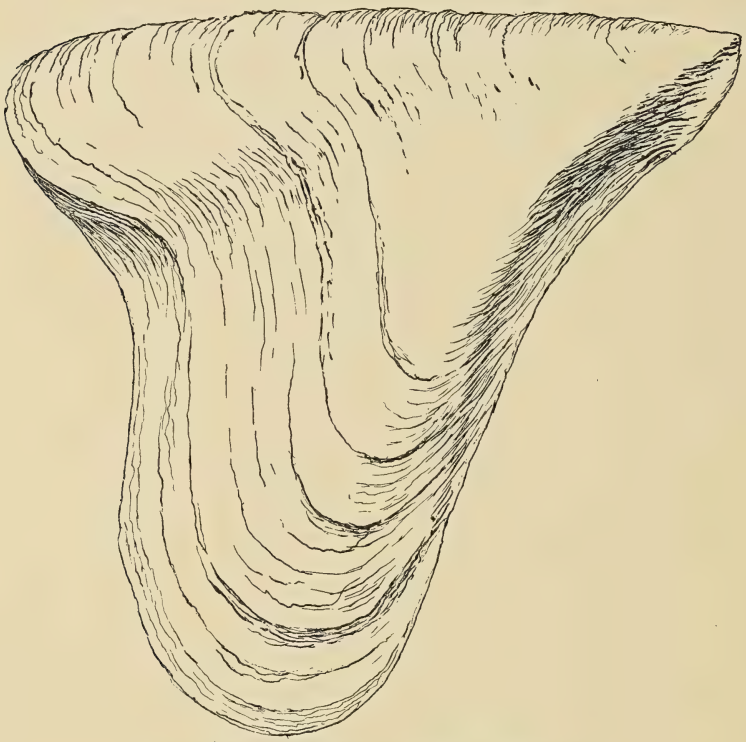


Fig. 1.—*Myalina copei*, sp. nov. Exterior of right valve.

this muscle is deeply sunken on the interior of the beak cavity. May not this be the case in the European shells also?

The species now in question may be described as follows:

Myalina copei, sp. nov.

Shell rather large, somewhat ponderous, much thickened. Subtriangular in general outline, the greatest convexity of the valves being along the umbonal ridge parallel to and a little within the buccal border, whence the body of the valves slopes gradually to the posterior margin. Left valve larger, longer, and deeper than the op-

posite. Hinge-line long, straight, or slightly arcuate; posterior extremity of the hinge extending beyond the body of the shell and forming a large posterior wing, which is more or less sharply rounded at the end; between the wing and the body of the shell the margin is rather deeply and broadly sinuate. Basal line short, rather narrowly rounded. Beaks slightly twisted in front and characterized by a lobe-like protuberance of moderate size between the beak and the byssal area. Ligamental area broad, longitudinally grooved by the lines for the ligament. From under the beak of the left valve a double ligamental groove extends to the interior of the valve, while the ligamental markings extend across it and down the anterior side of the

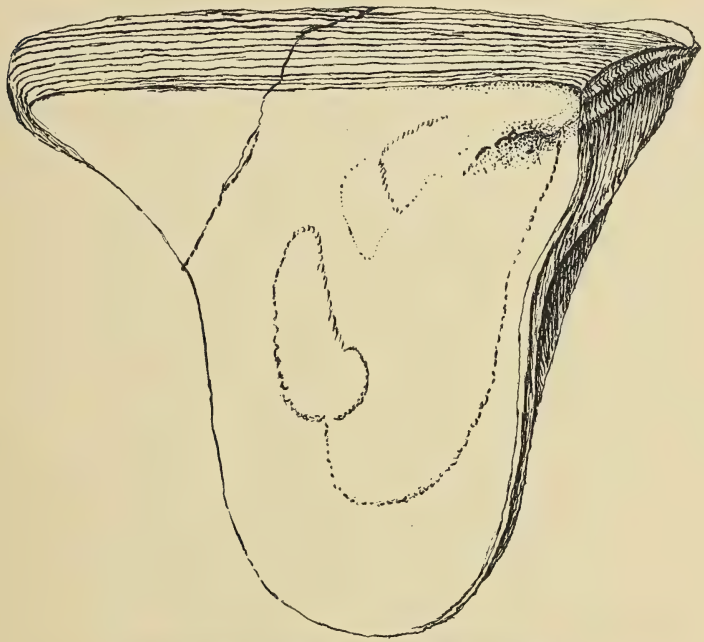


Fig. 2.—*Myalina copei*, sp. nov. Interior of left valve.

shell to the byssal opening, which is long, but not conspicuous. Right valve smaller and shallower than the left valve, and marked with a ligamental ridge corresponding with the groove in the beak of the left valve.

Exterior surface of the shell strongly lamellose with heavy lines of growth. Interior of each valve provided with a large, elongated posterior muscular impression; anterior muscular impression faintly

outlined; pallial line distinct, nearly marginal along the byssal border. Cavity of the shell deep, substance very thick.

Formation and locality.—From the Coal Measures on the McKenzie trail near Fort Griffin, Texas. Originally from collections made by Professor Edward D. Cope.

Article V.—OBSERVATIONS ON AND EMENDED DESCRIPTION OF HETEROCERAS SIMPLICOSTATUM WHITFIELD.

By R. P. Whitfield.

Plates XXIII–XXVII.

In the 'Geology of the Black Hills'[1] I described a fossil cephalopod under the name *Helicoceras* (*Heteroceras ?*) *simplicostatum*, having for study only a fragment consisting of less than one volution of the non-septate portion of the shell. The specimen was from ferruginous sandstone on the East Fork of Beaver Creek in the western part of the Black Hills, and was supposed to be from the Fort Benton group of the Meek and Hayden section. The fragment being without septa, a full description of the characters of the species could not be given, and it was doubtfully referred to the genus *Heteroceras* on account of the disconnected character of the whorls and the general marking of the shell.

During the present summer (1901) the Museum sent Dr. E. O. Hovey to the Black Hills to collect marine invertebrate fossils. Among the material which he collected and sent in from the Cretaceous beds near Buffalo Gap, South Dakota, are quite a number of examples of this species, showing more or less perfectly the features of the shell. By carefully manipulating the specimens the entire character of the species has been obtained, not only of the external features but also of the septa; and some features of this group of shells which were previously very imperfectly understood are distinctly revealed.

During the year 1876, while working at the collections brought from the Black Hills by Henry Newton, the geologist of the Jenney expedition, I uncovered what proved to be a part of a helicoid shell of an ammonitic genus which I

[1] Report on the Geology and Resources of the Black Hills of Dakota. With Atlas. By Henry Newton, E.M., and Walter P. Jenney, E.M., Washington, 1880. Palæontology by R. P. Whitfield.

described and figured in the 'Report' as *Heteroceras newtoni*. While freeing the shell from the matrix, I found in the opening through the whorls a specimen of *Ptychoceras*, with a second one lying obliquely across the upper whorl, but entirely unconnected with the *Heteroceras*. Their position, however, struck me as being peculiar and impressed me strongly with the idea that there must have been some connection between the two shells, as I had noticed several other imperfect examples or parts of examples of *Ptychoceras* on or near the larger cephalopods of this group while I had been freeing them from the rock. I did not, however, feel certain enough of the connection to venture a statement to that effect, but left the matter as one to be investigated, should material ever be obtained to allow of it. When the present collection was opened and an unusual number of *Helicoceras*-like shells observed, an effort was at once made to obtain the upper whorls of some of the individuals, with the results detailed in the following pages, which enable me to complete the description of the species and to add some features of the group previously only surmised. Accordingly a revised description of the species is given below.

Heteroceras simplicostatum *Whitf.*

Plates XXIII–XXVII.

Helicoceras (*Heteroceras ?*) *simplicostatum* Whitf., Palæontology of the Black Hills of Dakota. Explanation of plate xiv, foot-note.

Shell, as seen on a number of more or less imperfect individuals, rather large and in the end somewhat ponderous in character, consisting in the middle portion of several very laxly coiled volutions with a large umbilical opening. The earlier and later parts are irregularly bent or coiled, sometimes dextrally, but most frequently sinistrally. Section circular, except near the outer extremity of nearly entire individuals. The earlier portion of the shell is straight, *Hamites*-like in character, being bent upon itself after attaining a certain length as a straight tube, and returning on nearly the same plane and parallel to the first part for a considerable

distance (five or six centimeters), when it resembles the genus *Ptychoceras*, except that the two straight limbs may not be in close contact. The second return bending is of greater breadth, beyond which the tube takes a broad sweeping curve to beyond the first bend, when it curves downward and assumes beyond this point a more regular, helicoid curving, forming the middle portion of the organism. The space between the first and second sharp bendings, including the geniculated parts, if found separated from the other parts of the shell, would readily be taken for a section of an *Ancyloceras*. From the point above indicated the tube is deflected downward and becomes openly helicoid, with a broad, open umbilicus and laxly coiled volutions. Continuing this form of volution for one and a half to two turns, the tube is then suddenly directed downwards vertically for several inches, and again recurved upward to near the under surface of the last body whorl, forming a large vertical loop. None of the specimens in the collection shows satisfactorily whether this loop is parallel with or at right angles to the straight *Hamites*-like limbs of the initial parts of the shell.

In all the bendings of the coils, whether the shell is dextral or sinistral, the position of the siphuncle is always on the back of the volution and generally a little above the upper of the two lines of nodes or subspines subsequently to be mentioned. This constant position of the siphon in relation to the coils would indicate that the direction of the coiling of the tube was an embryonic condition.

The septa of the adult or middle portions of the species are very complicated in their ramifications, but in the straight parts of the earlier portions they are correspondingly simple. The older parts have the septa distant on the outer side of the whorl, but on the inner side they interlock and are so crowded that they seem almost to blend with each other. The variation between the different septa is very great, so great, in fact, that I can see no utility in figuring any one, or even several, as there is no possibility of specific determination from them.

The ornamentation of the shells of the species consists of a somewhat strongly marked, oblique annulation of the tube

throughout its entire length, growing stronger as the tube increases in size and age, and of two lines of nodes which mark the lower portion of the shell and which are developed into sharp spines of considerable length. On one fragment of a tube less than 12 mm. in diameter the spines, one on each row, are fully 2 mm. long. The nodes on the specimen of the vertical, non-septate portion of the tube figured are fully a centimeter high above the general surface, and only represent the cavity left on the inside of the shell, the shell having been entirely removed. The annulations are separated by rounded, concave interspaces and are generally rather sharp on the crests and quite generally simple, but with occasional intermediate ones on the outer surface of the volution. On the outer vertical portion of the tube the annulations become very strong and are interrupted at the nodes, and the section of this part of the tube becomes somewhat quadrangular toward the last. So far as observed, there is no minute surface marking beyond the annulations, though we are not sure that we have seen the actual outer surface, as the shell is very readily exfoliated, separating into numerous laminæ, often with very beautiful iridescence. On the middle or helicoid volutions the annulations are rather closely arranged, are directed backward on the upper side of the tube, forward on the face of the coil, and more strongly so on the lower surface. This gives a rather strongly retral curvature on the upper inner surface of the volution.

On a single specimen of an upper coil from the first abrupt bending of the shell backwards, the shell does not present the *Hamites*-like feature, but is, on the contrary, a very open spiral, rising fully six centimeters in making one volution from the point of the first abrupt bending of the shell. Hence it cannot be safely asserted that this *Hamites*-like feature of the earlier portions of the shell is a specific or even a generic characteristic.

If the slender tube described below is a feature of these shells, as I am inclined to believe, the straight part of the tube has extended some distance beyond the limits of the *Hamites*-like part and has necessarily passed over the top of

the second bending of the coil. On the best specimen in the collection this is shown to have been the case, as the lower shell is indented by it.

While working out some of the specimens of *Heteroceras simplicostatum* in the collection, we obtained a very slender shell which has a length of 26 mm. and a diameter of 1.5 mm. at the larger end, cylindrical in form and very gently curved, tapering to an almost hairlike point at the smaller extremity, where it seems to penetrate into the stone in the form of a minute, club-like point. The tube is obscurely annulated and the outer coating is highly iridescent. On scaling away the laminated iridescent shell from a portion of the specimen, it is found to be distinctly septate, with very simple septa, arranged, at the point measured, so that four of the chambers are 3 mm. in length. The septa appear to be simple undulations, three at least on the half-diameter, and one of these somewhat stronger or longer than the others. This specimen I take to be the initial part of the *Hamites*-like straight limb of this *Heteroceras simplicostatum*, which would, if this view be correct, extend far beyond the outer limit of the second geniculation. This view is strengthened by the best individual in the collection, in which the shell at the second bend is impressed where the straight limb has crossed it and lies partly imbedded therein. A second specimen of *Ptychoceras* has been obtained, where the tube is traced to where its diameter is less than half a millimeter.

In the 'Geology of the Black Hills,' at page 457, the statement is made, that, from the fact that the thickening of the shell of *Ptychoceras* appears to have taken place on the outside of the tube and not on the inner surface, the inference would be that the shell might have been at one time during life an internal appendage like that of *Spirula*. The same thickening of the external surface on the earlier parts of *Heteroceras simplicostatum* has been observed in this collection. And as there are numerous examples of *Ptychoceras mortoni* M. & H. among these fossils, this thickening has shown itself frequently by the exfoliation of the outer layers of the shells.

After having written the above description and remarks

on these shells, Prof. C. E. Beecher and Mr. C. Schuchert called my attention to the fact that Prof. Alpheus Hyatt had mentioned the compound feature of this species in his 'Phylogeny of an Acquired Characteristic,' where I find that he has placed it under *Heteroceras? nebrascense* Meek, referring it to his genus *Didymoceras*. On a direct comparison of the type of this species, figured in the Black Hills report with Meek's type of the above species, it was concluded that *Heteroceras nebrascense* was more nearly identical with *Heteroceras newtoni* Whitfield. Dr. E. O. Hovey also suspected, while in the field collecting the specimens, that these compound features existed.

In Eastman's translation of Prof. Zittel's 'Text-Book of Palæontology,' on p. 588, Family 33, Nostoceratidæ, it is stated that "the young of *Emperoceras* may remain Hamitean for a prolonged period, and then suddenly become Helicoceran or turrilitiform." But I cannot find that anyone has produced examples where *Hamites*, *Ancyloceras*, and *Heteroceras*, or the allied genera, are all combined in the one individual, though it would seem to have been considered a possibility. Then why the necessity of multiplying genera to so great an extent when Nature apparently has tried hard to reduce them?

EXPLANATION OF PLATE XXIII.

Heteroceras simplicostatum Whitf., page 68.

The figure is enlarged to less than five-fourths of the natural size. It is a top view of a specimen showing the prolongation of the *Hamites*-like straight limb across the second bending of the tube, into which it is distinctly impressed.

HELIOTYPE CO., BOSTON.

Heteroceras simplicostatum, Whitf.

EXPLANATION OF PLATE XXIV.

Heteroceras simplicostatum Whitf., page 68.

Side view of the specimen figured on Plate XXIII, and enlarged to about the same extent. It shows the back of the second limb of the *Hamites*-like portion of the shell and the coils of the *Heteroceras* features.

HELIOTYPE CO., BOSTON.

Heteroceras simplicostatum, Whitf.

EXPLANATION OF PLATE XXV

Heteroceras simplicostatum Whitf., page 68.

FIG. 1.—Top view, natural size, of a small specimen which retains the *Hamites*-like portion and also the *Ancyloceras*-shaped portion.

FIG. 2.—Top view of another individual, showing only *Heteroceras* features, with indications of the septa where the outer shell is absent.

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HELIOTYPE CO., BOSTON.

Heteroceras simplicostatum, Whitf.

EXPLANATION OF PLATE XXVI.

Heteroceras simplicostatum Whitf., page 68.

FIG. 1.—A figure, natural size, of the upper coil, above the *Ancyloceras*-like portion of the other individuals of a specimen which does not present the *Hamites*-like feature, but has been very laxly coiled.

FIGS. 2 and 3.—Two specimens, natural size, retaining only the upper coils, which present the *Ancyloceras*-like features.

FIGS. 4 and 5.—Back and side views enlarged to one and a half diameters of a portion of an outer coil from which the shell has been removed to show the character of the septa.

HELIOTYPE CO., BOSTON.

Heteroceras simplicostatum, Whitf.

EXPLANATION OF PLATE XXVII.

Heteroceras simplicostatum Whitf., page 68.

The figure is reduced to four-fifths of the natural size, and shows the last coil, vertically deflected and presenting the exaggerated features of the nodes and costæ of the apertural portion of the shell. The part where the large nodes occur is of a subquadrangular shape in section.

HELIOTYPE CO., BOSTON.

Heteroceras simplicostatum, Whitf.

Article VI.—DESCRIPTION OF A NEW TEREDO-LIKE SHELL FROM THE LARAMIE GROUP.

By R. P. Whitfield.

Plates XXVIII–XXIX.

A block of coniferous wood, highly mineralized (calcareous), was brought in from the east side of Alkali Creek, Wyo., 35 miles west of Edgemont, S. D., in 1900 by Mr. Barnum Brown of the Museum Expedition. The bed from which it was obtained is near the top of the Laramie Group, and known as the Triceratops Bed. The wood contains a group of the casts of borings of a very large species of Teredo-like shell, several of which measure about one and a quarter inches in diameter at the larger end, or near the end of the boring, at the point where the shell is located. A number of these retain remains of the shell well enough preserved for description and partial if not complete illustration. The block when first obtained was quite bulky, being eight or ten inches high and wide by a foot in length, but in freeing the cast of the borings from the matrix so that they could be studied and illustrated, it was necessary to reduce it considerably; so that only the portion containing the borings is preserved, of which the photographic plate given to illustrate it is just half-size. The block as it now remains contains thirteen of the borings more or less entire, with evidence of at least five others. There are also quite a number of other specimens which were detached from the block at the time it was collected.

In studying the characters of the shell as seen in specimens more or less freed from the matrix, but greatly exfoliated, it would appear that the shell is more closely allied to the genus *Turnus* of W. M. Gabb, as emended and illustrated by F. B. Meek, in Vol. IX of the Report of the United States Geological Survey of the Territories, and by F. Stoliczka and Tryon, than any other of the known genera of this group of

shells. Its great size, however, is somewhat startling as compared with the allied forms, which are minute, while this attains a transverse diameter of one and three eighths of an inch through the valves.

The valves have the feature of the rectangular notch in the anterior border, with a large shield-shaped piece filling the hiatus, which forms a section of a sphere, and is, so far as can be ascertained from the specimens, quite smooth, *i. e.*, destitute of surface corrugations. The valves have the usual oblique radiating sulcus passing from the beaks to the extreme basal point, and a secondary fainter one passing in front of the beaks to the angle of the rectangular notch; they also show the concentric lines parallel to the margins of the shell, so characteristic of the Teredinæ. The best preserved specimens show also the thin posterior prolongations of the valves into the tube to a length of over two inches beyond the posterior margin of the valves proper, giving a total length, in the specimen photographed for illustration, of three and one fourth inches. All of these features, except perhaps the thin posterior prolongation of the valves, are features which pertain to the genus *Turnus* as illustrated by the authors above mentioned. But beyond this I find, a little anterior to the beaks, evidence of a thickened hinge-plate which is divided into four small teeth on the right valve, which are opposite to and probably fitted into similar ones on the other valve. No appearance of a hinge structure posterior to the beaks has yet been observed.

There is unmistakable evidence of a thin shelly lining to the tube for some distance beyond the thin prolongation of the valves.

In most of its features, this Laramie shell resembles the Cretaceous *Turnus elegantulus* Meek, but it is more gaping behind, and the anterior rectangular hiatus is closed by a shield-shaped plate. It is certainly destitute of the internal ridge which is supposed to be a principal feature of that shell. From the living form, *Jouannetia*, it differs in the widely gaping posterior end, although apparently extended by smooth secretions of shelly matter, and materially so in its

equivalve shell. From Meek's *Goniochasma* and others it differs in wanting the internal ridge behind the beaks. I therefore propose for it the generic name *Xylophomya*, and give below a diagnosis of the generic characters observed.

Xylophomya, gen. nov.

Generic description.—Burrowing bivalve shells, widely gaping posteriorly, with a deep rectangular notch or hiatus in the anterior border. Basal margin prolonged into acutely triangular extensions. Valves marked by a narrow sulcus from beak to base and by a second fainter one anterior to it, reaching the margin at the angle of the hiatus. Hiatus filled by a broad shield-like plate. Hinge-plate divided, anterior to the beaks, into four minute tooth-like denticles on the right valve. Posterior margin of the valves prolonged in a smooth tongue-shaped extension, filling the diameter of the burrow, and apparently connecting with the lining of the tube.

Xylophomya laramiensis, sp. nov.

PLATES XXVIII–XXIX.

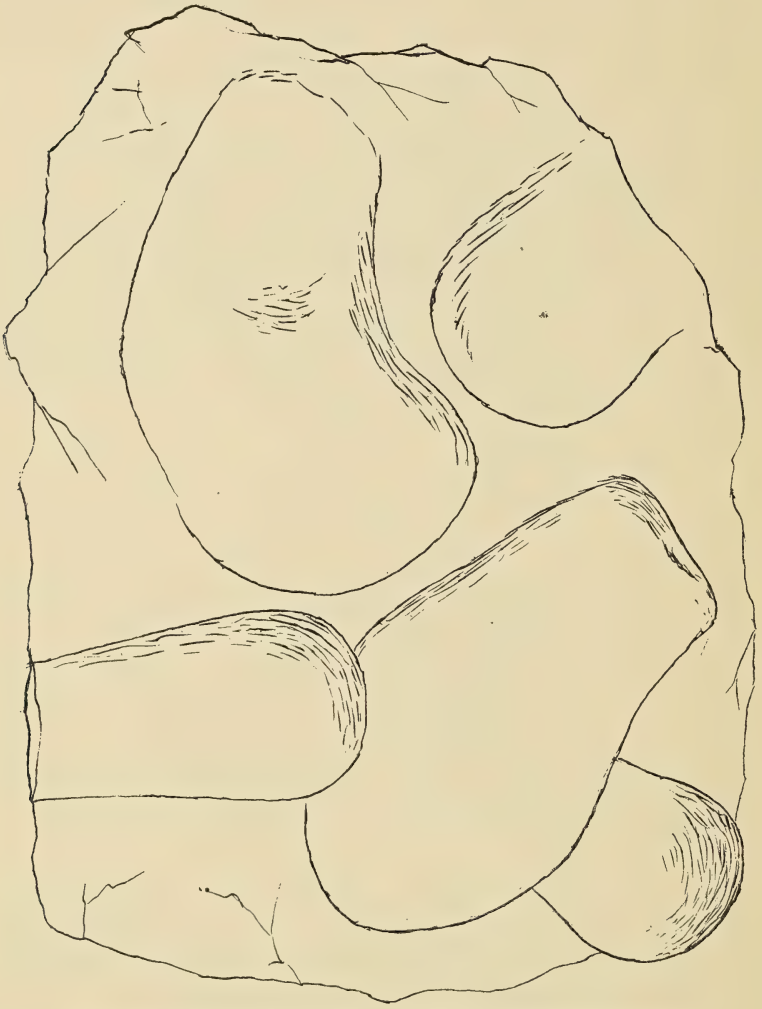
Shell large for the group, measuring one and a fourth inches in diameter, burrowing in wood or other substances; very ventricose and the valves extended backwards into the tube to the extent of two inches or more, gradually narrowing posteriorly, rounded behind. Surface of the valves marked with close concentric lines parallel to the margins. The anterior plate shield-shaped, broad, smooth on the exterior, as are also the posterior extensions of the valves.

Locality and Formation.—Alkali Creek, Wyoming, 35 miles west of Edgemont, S. D., in strata of the Laramie Group. Collected by Mr. Barnum Brown.

While examining these western forms I tried to find the plate filling the anterior rectangular hiatus in *Turnus elegantulus* Meek on specimens in an original block in the Hall Collection, but obtained only negative evidence.

Just after working out the block of this western form that served for the photograph illustrating the species I made a visit to the Cretaceous beds at Atlantic Highlands, N. J., and picked up a small slab evidently from the yellow sands at

the top of the hill, and found that it contained four more or less perfect casts of a Teredo-boring very closely resembling



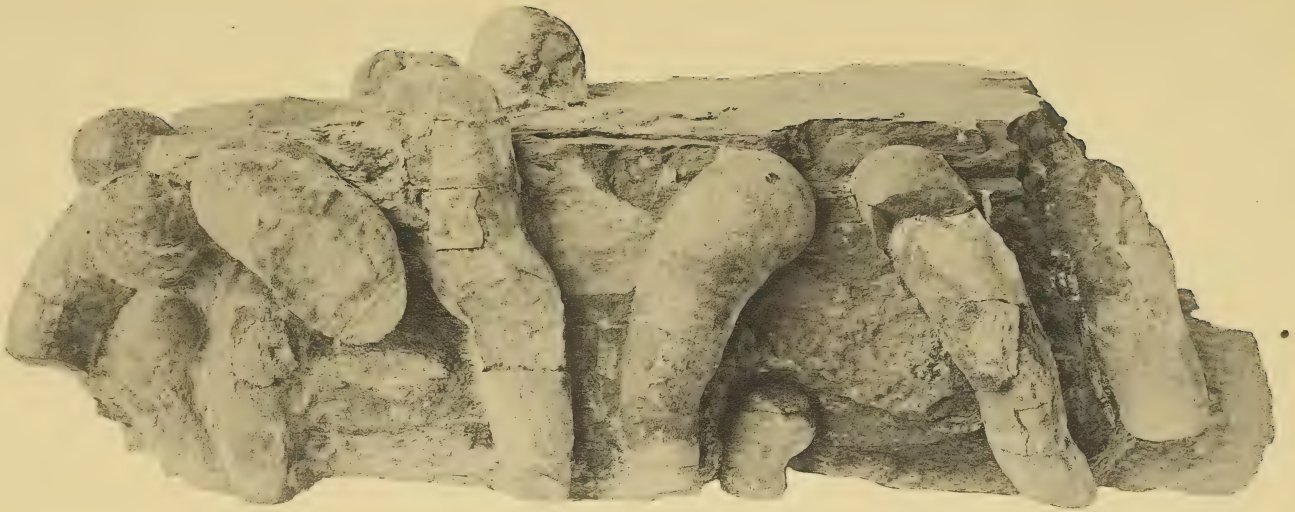
Casts of Teredo-borings from the Cretaceous beds at Atlantic Highlands, N. J.

the western ones. The outline figure here given is made from it.

EXPLANATION OF PLATE XXVIII.

Xylophomya laramiensis, page 75.

View, one half diameter of the original block after the wood had been cut away between and from around the burrow fillings.



New Teredo.

EXPLANATION OF PLATE XXIX.

Xylophomya laramiensis, page 75.

FIG. 1.—Back view, nat. size, of one of the separated burrows, which retains a portion of the shell showing the oblique umbonal furrow and the prolonged extension of the shell to the point marked *a*.

FIG. 2.—Side view of the same specimen.

FIG. 3.—Back view of a second individual which shows the shell to have extended to the point *a*.

FIG. 4.—A restored drawing of the anterior end of the specimen shown in Fig. 1, giving the form of the anterior shield-shaped plate and the anterior notch in the margin of the valves.

FIG. 5.—Lateral outline view of the valve, showing the markings of the surface as obtained from several specimens.

FIG. 6.—Outline showing the form of the valve.

FIG. 7.—Outline figure of the dorsal view of the end of the specimen Fig. 1 to show the extent of the shell proper, to the beginning of the posterior extension.

FIG. 8.—View of the anterior teeth as seen on a fragment chipped from between the beaks, 3 x.

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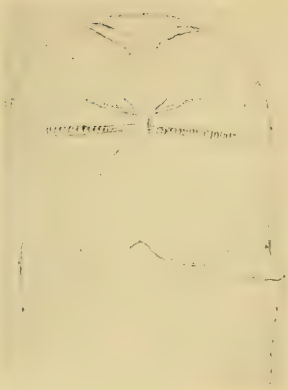

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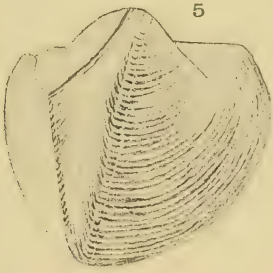

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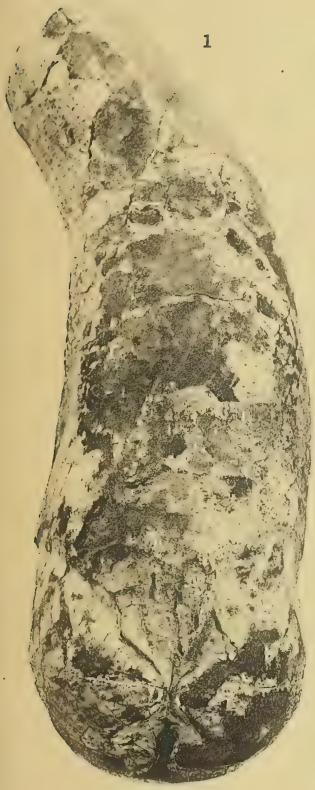

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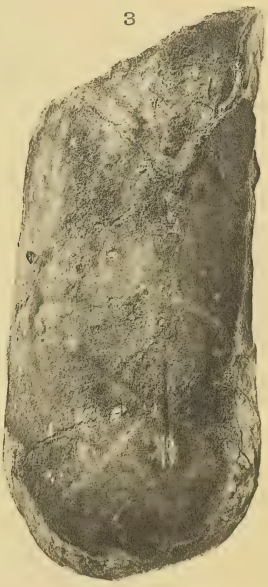

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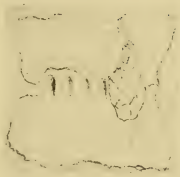

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HELIOTYPE CO., BOSTON.

New Teredo

Article VII.—DOLICHOCEPHALY AND BRACHYCEPHALY IN THE LOWER MAMMALS.[1]

By Henry Fairfield Osborn.

Skulls are classified according to their cephalic indices into three groups: dolichocephalic, mesaticephalic, and brachycephalic.—*Nature*, XXXIII, 4.

Dolichocephaly and brachycephaly are familiar terms in anthropology. The cephalic index, or ratio of breadth to length, marks a profound distinction between different races of man; it is one of the most stable of all racial characters, although no satisfactory theory or explanation of what it signifies has thus far found general acceptance among anthropologists.[2]

These facts render it all the more surprising that *skull* proportion, distinguished from *cranial* or brain-case proportion in man, has not been considered more generally by students of the lower mammals as of great value in the separation of races, as well as of profound morphological significance. It is true that certain mammals have been described as short- or broad-skulled, others as long- and narrow-skulled. As early as 1873 Kowalevsky demonstrated the elongation of the face in Ungulates for the accommodation of long-crowned teeth, but this does not explain the long free space or diastema in front of these teeth; the studies of Nathusuis (1864) on the proportions of the skull in races of pigs,

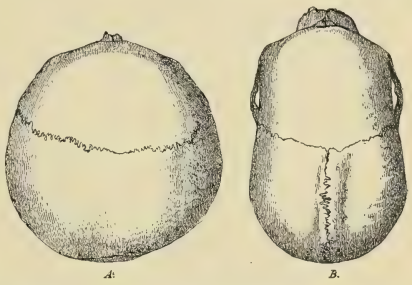

Fig. 1. Human Crania of dolichocephalic and brachycephalic type. After Huxley.

[1] Presented in Abstract before the New York Academy of Sciences, Nov. 8, 1901, and before the National Academy of Sciences, Nov. 13, 1901.

[2] I make this statement on the authority of Dr. A. Hrdlička of the American Museum of Natural History.

are well known; in 1895 Nehring referred to the long- and short-skulled races of dogs associated with early races of man; quite recently also Wortman (1899) has distinguished between short- and long-jawed races of Tertiary dogs, and Matthew (1901) has distinguished between the long- and short-skulled races of Oreodonts, as a basis of classification. These are a few examples, among many which might be found, of attention directed to such facts; but I am not aware of any general application of *dolichocephaly and brachycephaly as factors in cranial and dental evolution, and as correlated with the proportions of the limbs and habits of feeding.*

At all events the principle has not found its way into palæontological literature, with which I am fairly familiar, and was reached by myself independently and purely inductively while engaged upon the phylogeny of the Rhinoceroses (1900). After accumulating a great number of facts on the evolution of this baffling group the correlation of long limbs with long skulls (dolichopody and dolichocephaly) and short limbs with short skulls (brachypody and brachycephaly) suddenly appeared as a key, and was expressed in the following statement:

"It [the classification adopted] sets aside several homoplastic parallel characters heretofore employed in Rhinoceros evolution and attempts to establish a firmer basis *in the fundamental proportions of the skull, whether dolichocephalic or brachycephalic, in the correlated proportions of the body, and in the location of the horn cores.* These characters are found to be more distinctive of phyla than the pattern of the molar teeth."

The full bearings of the principle were only partly perceived at this time, and singularly enough I turned to the study of the Titanotheres for the Geological Survey Monograph without reference to my previous work on the Rhinoceroses and wholly unbiassed by any theory. Aided by Mr. W. K. Gregory about eighty-five skulls were measured and studied, hundreds of facts were noted which seemed to have no particular significance; finally all these data were put together and the conclusion was reached again, inductively, that *dolichocephaly and brachycephaly are among the dominat-*

ing factors in the skull of the Titanotheres, and that they are probably correlated with similar proportions in the trunk and limbs. This result, as in the case of the Rhinoceroses, placed the whole evolution of the family from its beginning in the Eocene period in a new light and directly contradicted the phylogenetic conclusions I had reached in 1896.

Considering the principle, however, as only a working hypothesis I read through various memoirs of Cope, Marsh, Earle, and others on the structure of the skull in the Rhinoceroses and Titanotheres and was delighted to find that dolichocephaly and brachycephaly explained a vast number of detailed facts which had been recorded abstractly by these authors without reference to their significance, not only in all parts of the skull but in the teeth. In many respects the teeth were proved to conform to the skull rather than the skull to the teeth.

In brief, the proportions of the skull were found to involve, as one might anticipate, every bone in the skull, but more particularly nasals, horns, zygomatic arches, palate, relations of the foramina in the base and side of the skull, the occiput, the mastoid and other bones around the auditory meatus, the premaxillary and mandibular symphyses, the jaw, the diastemata between and behind the teeth, the number and shape of the teeth, the shape, number, and relations of the cusps, and even, it would appear, the cingulum around the teeth. In other words all these characters were found correlated in many animals with the proportions of the skull, and consequently with the structure of the limbs and feet,—a quite unlooked for illustration of Cuvier's famous law of correlation.

This gratifying result suggested a superficial review of the mammals in general in respect to the same factors. The conclusions reached in this paper are therefore of a preliminary character.

We may first consider the skull in itself, then the correlation of its proportions with similar proportions in other parts of the body, the exceptions to such correlation and special reasons for them, some of the apparent causes of

dolichocephaly and brachycephaly, and finally some of the facts which await explanation.

In applying these terms to the lower mammals we refer to the *skull as a whole*, whereas in man the reference is only to the *cranium*.

The Long and the Broad Skull.

The three skulls photographed below from the American Museum collection (Fig. 2) are three nearly contemporary species of Eocene Titanotheres which illustrate admirably dolichocephaly, brachycephaly, and the neutral or inter-

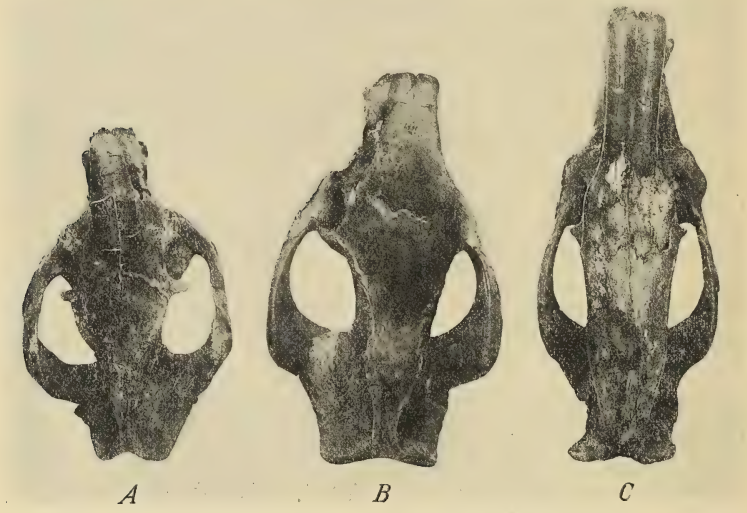

Fig. 2. Eocene Titanotheres. *A*, Brachycephalic, *Palæosyops paludosus*. *B*, Mesaticephalic, *Limnohyops manteoceras*. *C*, Dolichocephalic, *Telmatotherium cornutum*.

mediate condition of mesaticephaly. The species are the classic *Palæosyops paludosus*, the extremely long and narrow *Telmatotherium cornutum*, and the moderately broad *Limnohyops manteoceras*. The first and second species are believed to belong to side lines which became extinct; the third, more generalized, form is now believed to have given origin to the Oligocene Titanotheres, although this inference

awaits confirmation. The skulls of these Titanothere species differ from those of man and of Rhinoceroses in the fact that the cranium, or skull proper, does not vary in width so widely as the cheek arches or zygomata. It is chiefly the enormous expansion of the latter bones in *Brontotherium elatum* which makes the skull actually as broad as it is long. But while mainly a zygomatic expansion, that there is a very pronounced cranial and facial expansion is attested by the broad palate, relatively short and crowded dental series, transversely expanded horns, abbreviated nasals, short malar bridge in front of the orbit, abbreviated mastoid and paroccipital portion behind the external auditory meatus, transversely expanded occiput and occipital condyles, broad exoccipital and postglenoid processes, short, deep, and thick lower jaw with less prominent angle. There is no mistaking a typical brachycephalic for a dolichocephalic jaw, every contour and proportion is different. Analogous differences are observed among the Rhinoceroses.

The above are only a few of the correlated effects of skull proportion. In the comparison of all the Titanotheres from the beginning to the end of their remarkable history it is found that the primitive and central types are mesaticephalic, and the divergence is into brachycephaly and dolichocephaly. The following table presents the extremes of structure as observed especially in the Titanotheres.

CORRELATED SKULL CHARACTERS.

	BRACHYCEPHALY.	DOLICHOCEPHALY.
	Teeth.	
Dental series	Crowded	Elongate.
Diastemata	Closed	Increased.
Anterior premolars, pm $\frac{1}{1}$	Suppressed. One fang suppressed.	Persistent and spaced. Two fangs retained.
Intermediate tubercles of molars	Persistent	Reduced.
Opposite dental series	Convergent or arched	More parallel.

	BRACHYCEPHALY.	DOLICHOCEPHALY.
	Teeth.	
Grinding teeth	Shortened and widened.	Lengthened and narrowed.
Cingula between teeth	Suppressed	Persistent.
Canine teeth	Rounded and broadened	Elongate compressed.
Incisor series	Placed transversely	Converging anteriorly.
	Skull.	
Whole skull	Shortened and broadened.	Lengthened and narrowed.
Most of the constituent bones.	Shortened and broadened.	Lengthened and narrowed.
Palate	Broadened and flattened.	Narrowed and transversely arched.
Nasals	Shortened and spreading.	Long with incurving or straight sides.
Malar and maxillary bridge over infra-orbital foramen.	Narrowed	Broadened.
Infra-orbital foramen.	Not seen on side of face.	Conspicuous on side of face.
Lachrymal bone	Crowded into orbit	Exposed on side of face.
Lachrymal canal	Crowded into orbit	Seen on edge of orbit.
Zygomata	Broadened, especially in the "buccal plates"; in section broad rather than deep.	Elongate and vertically deepened; in section deep rather than broad.
Areas of insertion of masseteric and temporal muscles.	Increased	Balanced or retained.
Mastoid portion of periotic	Abbreviated	Exposure persistent.
Exoccipital, post-glenoid, and post-tympanic processes.	Broadened	Deepened and narrowed.
Post-glenoid and post-tympanic processes.	Approximated, especially below, enclosing the external auditory meatus.	External auditory meatus not closed below.

	BRACHYCEPHALY.	DOLICHOCEPHALY.
	Skull.	
Tympanic bulla	Thrust inward	Exposed laterally.
Foramen ovale and f. lacerum medius	Approximated	Separated by a bridge of bone.
Foramen lacerum medius and f. lacerum posterius	Approximated	Separated by periotic.
Alisphenoid canal	Abbreviated	Elongate.
Presphenoid	Abbreviated	Elongate.
Vomer	Thrust backward	
Premaxillary symphysis	Abbreviated	Elongate.
Horns	Transversely expanded	Not so expanded.
	Jaw.	
Jaw	Shortened, thickened, deepened.	Elongate, with straight lower border and backwardly produced angle.
Area of insertion for temporal muscle	Reduced	Balance maintained.
Coronoid process	Reduced	Lengthened anteroposteriorly.
Mandibular symphysis	Abbreviated	Elongate.

The above characters are chiefly observed in the Titanotheres, in which the most careful comparison of dolichocephalic and brachycephalic skulls has been made.

Many characters in the first column apply with equal force to the Primates which are progressively brachycephalic, marking the passage from the more dolichocephalic Lemurs and Baboons to the more brachycephalic Lemurs, Monkeys, and Apes.

On the other hand many characters in the second column apply also among the Horses, which are progressively dolichocephalic.

Many of these characters also distinguish the brachycephalic from the dolichocephalic Rhinoceroses.

There are, however, notable exceptions, as shown below.

Unequal Elongation of Face and Cranium.

When we compare a long-skulled with a short-skulled Rhinoceros the skull of the latter appears compressed antero-posteriorly, as if composed of india-rubber, all the parts being affected alike (Fig. 3). But although both the face and the cranium in the Rhinoceroses and Horses appear to be affected, this is by no means a general principle. In the Titanotheres the face is shortened and the cranium greatly elongated, so

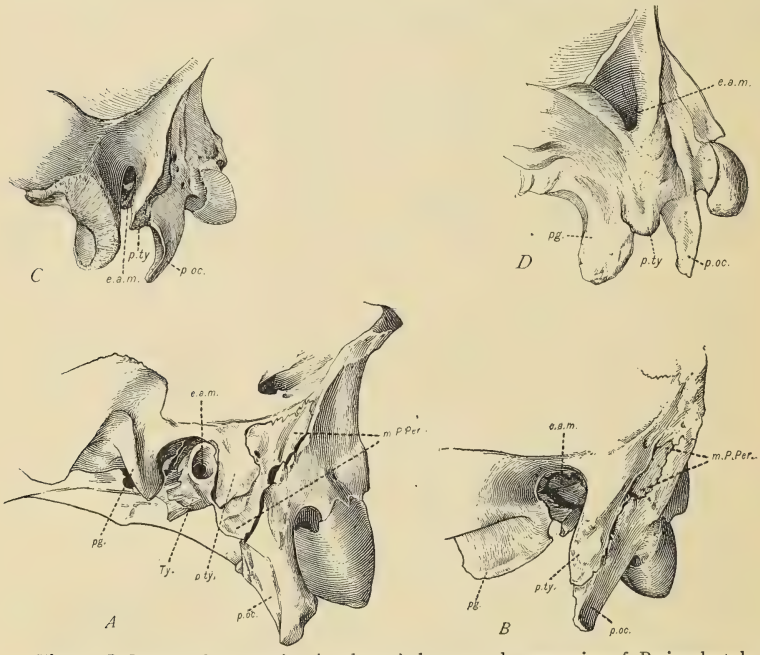

Fig. 3. Influence of progressive brachycephaly upon the ear region of Perissodactyla. *A*, Dolichocephalic, *Equus caballus*. *B*, Mesaticephalic, *Tapirus*. *C*, Dolichocephalic, *Ceratorhinus sumatrensis*. *D*, Brachycephalic, *Rhinoceros sondaicus*. Disappearance of mastoid portion of periotic, *m. P. Per*, and enclosure of auditory meatus, *e. a. m.*, inferiorly.

that the distance between the orbit and the external auditory meatus is very great, the molar teeth extending back beneath the orbit. In the Horses, on the other hand, the face is greatly elongated and the cranium only moderately so, and this is true of by far the greater number of long-skulled Ungulates. Such unequal elongation of different regions of the skull will

no doubt be found by examination in every family of mammals.

But every exception has some special adaptive significance. For example, the nasals in the Tapirs and the Proboscidea are abbreviated not as an expression of brachycephaly but in correlation with a prehensile upper lip or proboscis. The mastoid portion of the periotic, generally exposed in dolichocephalic types such as the Horses, persists also in the brachycephalic Primates, for the insertion of one of the most important muscles of the neck. The contrasts of brachycephalic with dolichocephalic characters, brought out in the above table, therefore are limited in the various mammalian families by special adaptive conditions.

Significance of Dolichocephaly.

The earliest known Ungulates have moderately elongate or mesaticephalic skulls, from which it follows that brachycephaly and dolichocephaly are for the most part secondary.

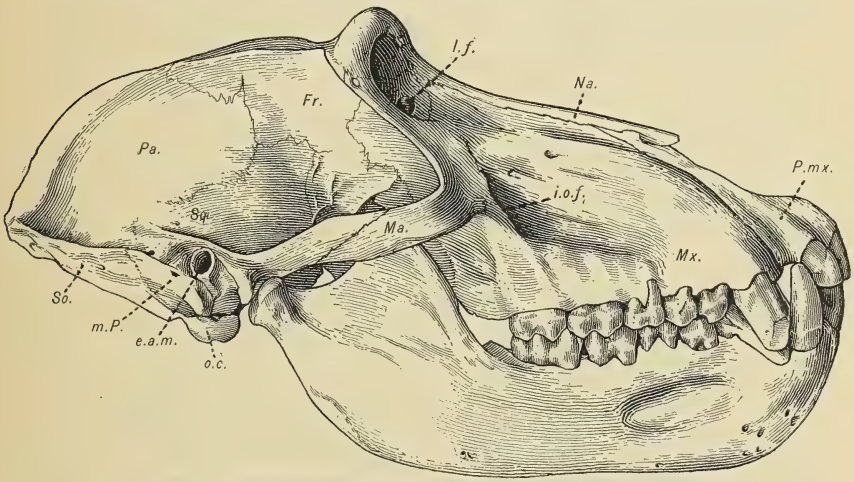

Fig. 4. Dolichocephalic skull of Baboon, *Cynocephalus olivaceus*.

In Titanotheres and Rhinoceroses they are definitely progressive characters. The earliest horses (*Protorohippus*, *Hyracotherium*) are already specialized in the direction of

dolichocephaly, which, it is important to note, is here accompanied by progressive lengthening of limb.

In fact, dolichopody, in the broad sense of lengthening of limb, is in general an adaptation to cursorial habits and speed, associated with life on the plains, cropping front teeth, absence of defensive weapons.

The lengthening of the limb for the purpose of speed appears in fact to have been the prime correlate of the lengthening of the skull. There are numerous cases where the elongation of the limbs and of the skull have developed *pari passu*, notably in the case of the long-limbed Rhinoceroses as well as in the Horses. It is also very characteristic of the long-limbed Elotheres, which have extraordinarily long skulls, in contrast with the remotely related Pigs. We reach the conclusion that both dolichocephaly and lengthening of neck, in order to enable grazing animals to reach the ground, may be primarily due to lengthening of limb.

Exceptions to the Correlation of Dolichocephaly with Dolichopody and of Brachycephaly with Brachypody.

There are, however, many exceptions to the correlation of long limbs and long skulls. Among the races of men, although there are notable cases of such correlation, there are also notable exceptions; the bipedal Primates generally offering an exception to quadrupedal mammals.

Again, the cursorial long-limbed Hyracodonts are a family of Rhinoceroses with very long limbs and short skulls. Here, however, brachycephaly is compensated for in a measure by length of neck, possibly also by a substitution of browsing for grazing habits. The most remarkable elongation of the limbs and neck, in connection with an only moderately elongate skull, is in the Giraffes, which are typical tree-browsers. The opposite combination of long limbs with very long head and short neck is exemplified in the Moose (*Alces*), habitually a browser, which, like the giraffe, extends its mouth to the ground with great difficulty. Whenever an animal acquires

the shrub- or tree-browsing habit, therefore, as in the case of *Rhinoceros bicornis*, a new factor is introduced. Other families in which the browsing habit appears to have been acquired secondarily are the Chalicotheriidæ, Agriochœridæ, and Anoplotheriidæ.

Again, among the Carnivora the Dogs are typically long-skulled and long-limbed or cursorial animals. A dog feeds in a standing position, the food held upon the ground by the fore feet, the limbs being somewhat flexed. In this family the skull and limb correlation seems to hold good. Moreover, the short-faced dogs are generally short limbed. Cats, on the other hand, present a decided exception, because they are brachycephalic and dolichopodal, the Cheetah, for example, having an exceptionally short skull and elongate limbs. We should recall, however, that cats always feed in the recumbent or semirecumbent position, crouching or lying down. Thus the abbreviation of the Cat skull is correlated with the functions of the teeth and not with those of the limbs, because the Cats have a special position in feeding. Similarly the Proboscidea are extremely brachycephalic and long-limbed, but the exceptional elongation of the limbs is compensated for by the development of a proboscis.

To sum up, the numerous exceptions to the correlation of skull and limb proportions are mostly capable of special adaptive explanations, and, as we shall see below, when correlation does occur it is probably adaptive also. In brief, there is no innate, invariable law of correlation; skull and limbs may or may not be dependent upon each other.

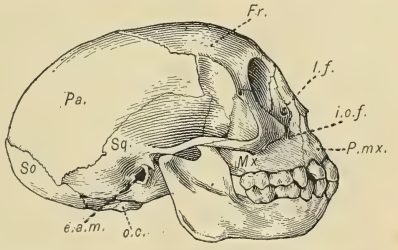

Fig. 5. Brachycephalic skull of Monkey, *Maccacus* sp., juv.

But when such correlation does occur, as in *Telmatotherium* or *Hyopotamus* on the one hand, or in *Teleoceras* on the other, it is likely to affect the whole skeleton: length of the cervical and dorsal vertebræ, form of the scapula and ilium, length

of the metapodials. So complete is the correlation that we can, for example, immediately distinguish between the elements of the pes of a long-skulled and of a short-skulled Rhinoceros.

Eliminating all the exceptions, there appear to have been two general causes for the elongation of the skull. First, the elongation of the face for the accommodation of very long hypsodont grinding teeth in front of the orbit, as observed by Kowalevsky. Second, the elongation of the skull as a whole, correlated with the elongation of the limbs, an adaptation to grazing and cursorial habit.

No Adequate Theory of Brachycephaly.

It is much more difficult to account for progressive brachycephaly. An adequate theory of its causes is still wanting, as shown by the following examples:

Among Primates the shortening of the skull takes place *pari passu* with the increasing use of the manus in conveying food to the mouth; this is well illustrated by the contrast between the quadrupedal, long-skulled baboons and the more bi-pedal short-skulled monkeys.

We are especially at a loss to offer any adequate explanation of the causes of progressive brachycephaly in mammals which seem to suffer thereby a reduction and compression of the dental series. In certain Titanotheres and Rhinoceroses the shortening of the skull seems to crowd and diminish the usefulness of the teeth, an apparently inadaptive process.

The observations of Nathusius led him to the conclusion that among the Suidæ abundant food tended to shorten and broaden the head and the face. Darwin observes that domestication tends to shorten the bones of the face in many animals.

Among Carnivores, and among the long-horned Titanotheres, abbreviation of the skull favors the effective use of the canine tusks and of the paired horns respectively. But brachycephaly also develops to an extreme in certain defenceless types, such as *Cyclopidius* among the Oreodonts.

Further investigation and comparison may produce some general law.

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Article VIII.—THE FOUR PHYLA OF OLIGOCENE TITANOTHERES.[1]

TITANOTHERE CONTRIBUTIONS, No. 4.[2]

By Henry Fairfield Osborn.

My first review of this group, entitled 'Cranial Evolution of Titanotherium' (Titanotherium Contributions No. 3), was based upon examination of only part of the original material; it included a preliminary revision of the species by the distinction of growth, sexual and variable characters, and by the method of sections of different parts of the skull.

Two errors invalidated this review. First, the stratigraphical or geological sequence of the types examined was not fully known, and, second, as a consequence, the group was treated as more or less monophyletic with certain side branches.

This second review is an abstract of a portion of the results obtained for the U. S. Geological Survey monograph, 'The Titanotheres,' now in preparation. It covers practically all the type material in the Yale, National, American, and Harvard Museums, and advantage has been taken of the invaluable field observations by Hatcher of the levels on which the different skulls in the National Museum collection were discovered. The section method also has been very greatly extended and, taken in connection with the teeth and the detailed structure of the skull, has proved to be a sure criterion of specific and phyletic character.

Beginning in January, 1901, the work for the monograph advanced uninfluenced by any theory as to the evolution of these mammals until finally, in July, all the data were put together with most interesting results, which may be briefly summarized as follows:

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[1] The late Professor O. C. Marsh of Yale University devoted many years to the collection of materials and preparation of plates and figures for a monograph on the group treated in this paper. He also completed several valuable papers, but left no manuscript. Full acknowledgment of this important service to palæontology will be made by the writer in the final treatise.

[2] See contributions 1–3 in Bibliography.

1. THE ADAPTIVE RADIATION.

The Oligocene Titanotheres consisted of at least four contemporary phyla, to which the prior generic names *Titanotherium*, *Megacerops*, *Symborodon*, and *Brontotherium* may be applied.

They represent an adaptive radiation for different local habitat, different modes of feeding, fighting, locomotion, etc., which took origin, in part at least, in the Middle or Upper Eocene. Europe and Asia also may have shared in this radiation, since Titanotheres are now definitely known in the Balkan region.

The main phyletic characters are analogous to those recently (Osborn, 1900, p. 231) determined among Rhinoceroses; the great antiquity of the lines leading to the existing species of Rhinoceroses necessitated the revival of a number of discarded generic names to distinguish them. Similarly the separateness of four of the Titanothere phyla, throughout the Oligocene and possibly from the Eocene, render it desirable to revive certain generic names which in my first review I considered undefinable.

Radiation involved three main sets of characters, two of which were correlated:

First, dolichocephaly and brachycephaly, associated with numerous changes in the skull and teeth, and, in at least two phyla, with longer and shorter limbs.

Second, four distinct types in the shape and position of the horns, correlated with the structure of the nasals and frontals and indicative of different modes of combat among the males.

Third, canines of different form; and, finally, the presence of one or two pairs of functional incisor teeth, or the total degeneration of these teeth.

2. THE FOUR GENERA.

Titanotherium Leidy applies to long-limbed animals with long skulls, persistently long and broad nasals, short triangu-

lar horns placed slightly in front of the eyes, vestigial incisors, $\frac{2-0}{2-0}$, large canine teeth. Known from the base to the summit of the Oligocene.

Megacerops Leidy applies to Titanotheres with broad skulls, nasals progressively shortening, short horns rounded or oval in section, shifting anteriorly, one or two pairs of incisor teeth, $\frac{2-1}{2-1}$, medium sized canine teeth. Known from the base to the summit of the Oligocene.

Probably related to this are the subgenera of the types named *Allops* and *Diploclonus* by Marsh, differing from the above in horn characters. Known chiefly from the Upper Beds.

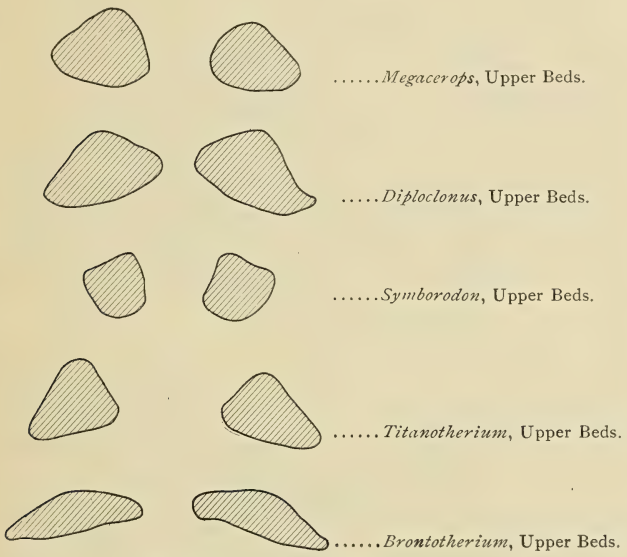

Fig. 1. Characteristic basal horn sections.

Symborodon Cope includes Titanotheres with skulls of varying proportion, nasals slender and progressively shortening, horns elongate and peculiar in being placed above the eyes instead of shifting forwards, incisors vestigial $\frac{2-0}{2-0}$, canines small, approximated. Known only from the Middle and Upper Beds.

Brontotherium Marsh embraces the largest Titanotheres, with very broad zygomatic arches, nasals shortening while horns elongate and shift forwards; incisors persistent, $\frac{2}{2}$ in the males, canines stout and obtuse.

Representatives of *Titanotherium* and *Megacerops* can now be continuously traced from the base to the summit of the Oligocene. Primitive species of *Brontotherium* also appear at the base, although the phyletic sequence through the Middle to the Upper Beds is not so clear. *Symborodon* suddenly appears in the Middle Beds.

3. NEWLY OBSERVED PROGRESSIVE CHARACTERS.

In addition to the progressive and retrogressive characters previously recorded by various writers (Osborn, 1896, pp. 162–174), are several of great value in the determination of species. (1) In the complication of the premolar teeth, one or more phyla progress in common, although the rate is unequal; for example, the double internal cones of the upper premolars are precociously developed in *Titanotherium* and very gradually so in *Megacerops*. (2) The cranial and many of the dental characters are profoundly affected by the progressive shortening or lengthening of the skull as recently explained in some detail by the writer (Osborn, 1902). (3) The cingulum around the molar and premolar teeth becomes progressively stronger in *Titanotherium* and *Megacerops*, and progressively weaker in *Symborodon* and *Brontotherium*. (4) The persistence or degeneration of incisor teeth are far more constant systematic characters than appeared to be the case in my first review.

In brief, each genus or phylum has its distinctive, persistent, progressive, and retrogressive characters, of which the above are a few examples out of many.

4. THE SUCCESSION OF SPECIES.

Phylum I.

Dolichocephalic Titanotheres with short, divergent, triquetrous horns placed slightly in advance of the orbits; nasals elon-

gate and square; incisors vestigial; canines very long and pointed; cingulum progressively developing; premolars $\frac{4}{4}$; *buccal processes of zygomata deep rather than broad.*

Genus TITANOTHERIUM Leidy.

The type of the genus is *T. proutii* Leidy, represented by the posterior portion of a jaw fortunately preserved in the National Museum, recorded from the base of the Titanotherium Beds. The genus is further characterized by a comparison of *T. heloceras*, *T. trigonoceras*, and *T. ingens*. It may have taken origin from *Diplacodon elatus* or *D. emarginatus* of the Upper Eocene or Uinta Beds.

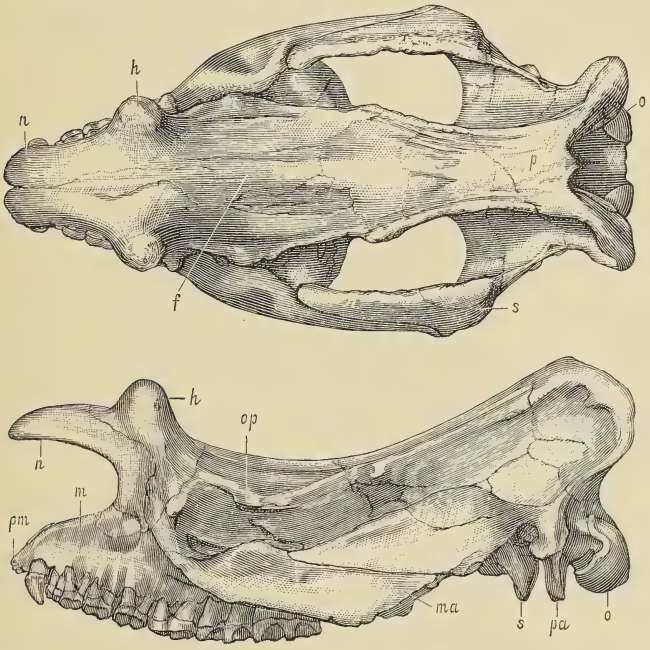

Fig. 2. *Titanotherium heloceras* (Cope). (U. S. Nat. Mus. No. 4260, Sk. Q.) × $\frac{1}{8}$.

LOWER BEDS.

T. heloceras *Cope.*—This is probably the earliest and most primitive representative of the long-skulled series. The doubt

arises from the imperfect condition of the type. With this species, however, is probably associated a skull (Nat. Mus. No. 4260) definitely recorded by Hatcher as from the Lower Beds and exhibiting a number of undoubted *Titanotherium* characters.

MIDDLE BEDS.

T. trigonoceras *Cope.*—Animals of middle size with long metapodials, represented by numerous specimens in the American and National Museums, show the state of evolution of this phylum in the Middle Beds. As compared with *T. heloceras* there is a marked progression in size, in the shaping of the horns, the development of the paired premolar cones, and of the cingulum on the grinding teeth.

UPPER BEDS.

T. ingens *Marsh* (Syn., *Menops varians* Marsh).—These very large, long-skulled and long-footed Titanotheres, first described by Marsh as *Brontotherium*[1] *ingens*, are definitely recorded by Hatcher from the Upper Beds, and show a corresponding increase in size and in all other progressive characters. The incisors are vestigial, the canines very long and powerful; the cingulum on the grinding teeth is very pronounced in both males and females. There is a marked difference between the sexes in the size of the horns and canines.

Phylum II.

Brachycephalic Titanotheres with short horns shifting forwards, rounded to oval at summits; nasals progressively reduced in length and broadening at the extremities; one or two pairs of persistent incisor teeth, above and below; canines pointed, of medium length; premolars, $\frac{4-4}{4-3}$; *zygomata progressively expanding into convex buccal processes; cranium not greatly produced behind zygomata.*

[1] As explained below, the name *Brontotherium* applies to the animals called *Titanops* by Marsh.

Genus MEGACEROPS Leidy.

This genus may have taken origin in the broad-skulled *Limnohyops manteoceras* or *Palæosyops paludosus* of the Eocene, although no horned type of the latter is known. It is known from the imperfect type of *M. coloradensis* and a very rich variety of species from the Lower, Middle, and Upper Beds, which have previously been referred to other genera. In the typical members the horns are slightly divergent and retroverted. There is a wide variation in progressive character between such species as *M. brachycephalus* and *dispar*, *M. bicornutus*, *M. selwynianus*, *M. tichoceras*, *M. robustus*, but it is found that the variations of age, growth, and sex, especially in species such as *M. dispar* and *M. robustus*, bridge over the differences between the types of said species and present intermediate forms. Furthermore these species are much more closely united to the general type of *Megacerops* than to any other genus.

LOWER BEDS.

Megacerops brachycephalus, sp. nov.

The type of this species is No. 4261, U. S. Nat. Mus. It includes very small, broad-skulled Titanotheres with very rudimentary second internal cones upon the upper premolars; nasals elongate, narrowing anteriorly, as in *Palæosyops*. Horns of anteroposterior oval section placed above orbits. It is represented in the National Museum by numerous skulls besides the type, all

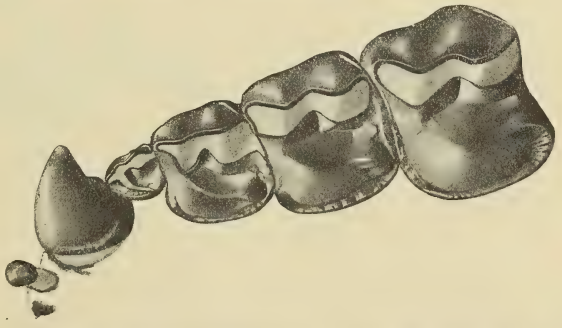

Fig. 3. *Megacerops brachycephalus.* (U. S. Nat. Mus. No. 4258, Sk. F.) Not the type. $\times \frac{1}{2}$.

collected and recorded by Hatcher. One of these skulls was provisionally referred by him to *Teleodus avus*, from which this species is quite distinct.

MIDDLE BEDS.

Megacerops dispar *Marsh* (Syn., *Brontops validus* Marsh). —Represented by the type, No. 4941, U. S. Nat. Mus., and numerous fine male and female skulls in the National Museum, collected and accurately recorded as to level by

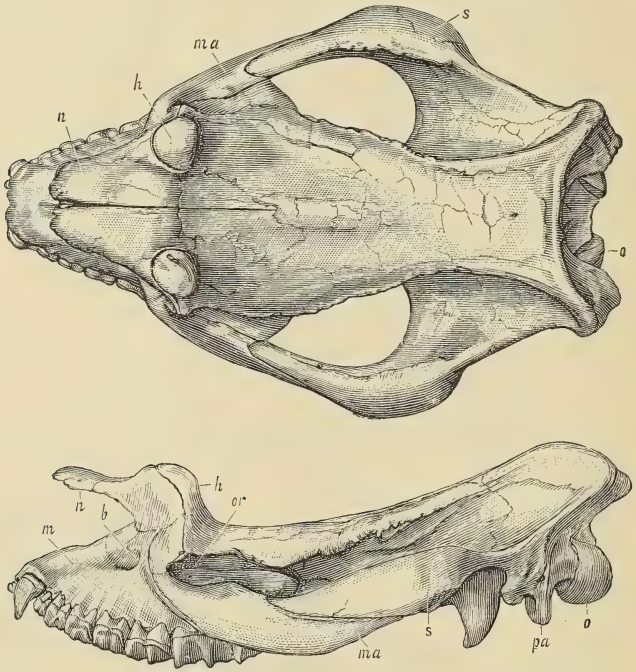

Fig. 4. *Megacerops brachycephalus.* (U. S. Nat. Mus. No. 4258, Sk. F.) Not the type. This skull was figured by Marsh (Amer. Jour. Sci., Oct., 1887) as *Brontops dispar.* × $\frac{1}{8}$.

Hatcher. The incisors vary from two to one. Canines prominent, pointed. Premolars, $\frac{4-3}{4-3}$, with internal cones more distinct than in *M. brachycephalus.* Nasals shorter; horns longer, broader in section at the base; zygomata more expanded.

LEVEL NOT RECORDED

Megacerops avus *Marsh.*—This type jaw, distinguished by the presence of three lower incisors, belongs to a much larger animal than *M. brachycephalus*. The presence of an outer lower incisor may be due to reversion or to the retention of a milk tooth; all young Titanotheres have three milk incisors. The formula, $I_{\frac{3}{3}}$, $P_{\frac{3}{3}}$, does not appear sufficient to remove this type generically, because the form of the canine, shape of the jaw, feeble development of the cingulum, etc., lead to placing it in *Megacerops*.

M. coloradensis *Leidy.*—Horns of medium length, of relatively slender cylindrical section. Nasals elongate, decurved, and narrow anteriorly. This is the type species.

M. angustigenis *Cope.*—Type in Ottawa Museum. Horns as in *M. coloradensis*, but nasals abbreviated and expanding anteriorly.

M.? selwynianus *Cope.*—Level not recorded, probably Middle Beds. Type in Ottawa Museum. Nasals extremely narrow, elongate, with highly arched inferior surface as in the species next to be described.

MIDDLE BEDS.

Megacerops bicornutus, sp. nov.

Type No. 1476, cotype No. 1081, Amer. Mus. Horns directed anteriorly. Hornlets upon the inner and anterior mid-portion of the horn. Basal section of the horn slightly oval, subtransverse. Nasals narrow and relatively elongate. Sharp malar bridge in front of orbit. Orbit large.

This animal stands nearest *M. selwynianus*, although distinguished by the greater size and slightly greater width of the nasals. The sharp malar bridge is the most absolute character. The two hornlets are possibly variations.

UPPER BEDS.

Megacerops tichoceras *Scott & Osborn.*—Type skull in Harvard Museum. This is distinguished from *M. dispar* by

the somewhat abbreviated nasals, greater expansion of the buccal processes, and two distinct internal cones upon the superior premolars. It is represented also by a number of

Fig. 5. *Megacerops bicornutus.* (Amer. Mus. Nat. Hist. No. 1476.) Type. $\times \frac{1}{8}$.

large skulls in the National Museum definitely recorded by Hatcher from the Upper Beds.

Megacerops marshi, sp. nov.

Type, Skull No. 501, cotype, skull No. 1445, Amer. Mus. Nasals elongate and square distally, horns short, of oblique oval basal section, overhanging the maxillæ, or projecting forwards or outwards. Incisors, $\frac{2}{2}\frac{2}{2}$. Canines short, tetartocones of premolars moderately developed.

These skulls were previously confused by the writer with *T. trigonoceras*, from which they are readily separated by the horn section, which relates them to some of the primitive types of *M. brachycephalus* and equally to *M. robustus*. The canines are more obtuse than in *M. dispar*, and the superior

incisors resemble those in *Brontotherium* rather than in *M. robustus*.

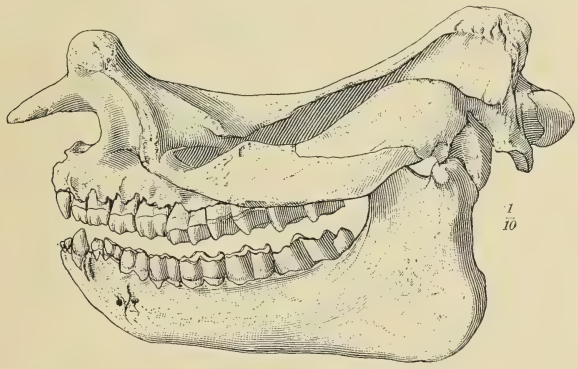

Fig. 6. *Megacerops marshi.* (Amer. Mus. Nat. Hist. No. 501; jaw No. 516.) Type. This skull was figured by Osborn (1896, p. 181) as *Titanotherium trigonoceras.*

Megacerops robustus *Marsh.*—Type in Yale Museum. Numerous skulls in the American, Princeton, and National Museums. Recorded by Hatcher from very summit of the Upper Beds. In skull development this represents an extreme evolution of the *M. brachycephalus-M. dispar* series. It is, however, distinguished from *M. dispar* by the presence of diastemata behind the canines, retarded development of the tetartocones on the superior premolars, broadly transverse horn-section, procumbent position of the horns.

The above-described new species, *M.* (? *Diploclonus*) *bicornutus*, from the Middle Beds is possibly a connecting form between *Megacerops* and the aberrant species from the Upper Beds termed *Diploclonus amplus* by Marsh. The latter is distinguished by short, divergent horns of peculiar triquetrous section, with incisors $\frac{1}{?}$, and elongate canines flattened posteriorly. The animals called *Allops* are certainly more closely related to *Megacerops* than to either *Titanotherium*, *Symborodon*, or *Brontotherium*, but their phyletic position is uncertain.

Genus ALLOPS Marsh.

Syn. ? *Diploclonus* Marsh.

Canines lanceolate, flattened posteriorly, incisors $\frac{1}{1}$. Horns with greatest diameter progressively transverse, pointed outwards and forwards.

The distinctness of this genus is doubtful.

UPPER BEDS.

Allops serotinus *Marsh.*—Superior premolars with small postero-internal cusps (tetartocones). Represented by two skulls in the National Museum, recorded from the Upper Beds. No connecting crest between the horns.

Allops crassicornis *Marsh.*—Type No. 4289, Nat. Mus. Superior premolars with large postero-internal cusps; cingula

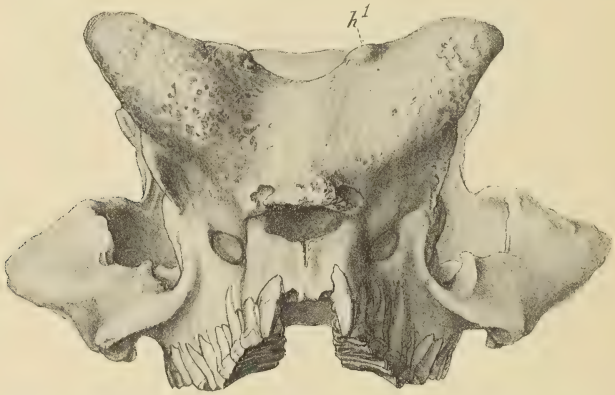

Fig. 7. *Diploclonus amplus* (Marsh). (Yale Museum.) Type. $\times \frac{1}{8}$.

more prominent; zygomata with flattened buccal processes. No connecting crest between the horns.

Allops amplus *Marsh.*—Type in Yale Museum. Characters similar to the above with the exception of a strong connecting crest between the horns and a pair of rugose internal hornlets on the horns, hence the term ' Diploclonus.' It is possible that this species descended from *M.*

bicornutus as a member of a collateral phylum distinguished by internal hornlets. In such case *Diploclonus* may prove to be a valid subgenus.

Phylum III.

Medium-sized Titanotheres with long horns placed more directly above the orbits, of deep anteroposterior diameter at the base, oval at tip; connecting crest feeble or wanting. Nasals thin; skull proportion varying in the species. Incisors degenerate. Canines very small, approximated.

Genus SYMBORODON Cope.

Syn., *Anisacodon*, *Diconodon* Marsh.

This genus is characterized from the types of *S. torvus*, *S. acer* in the American Museum, and of *S. montanus* in the Yale and National Museums. It is known only from the Middle and Upper Beds, but is entirely distinct. It agrees with *Titanotherium* in the disappearance of incisor teeth, but differs from it absolutely in the horn and nasal structure. It is also widely separate, both in cutting teeth and horn structure, from *Megacerops* and *Brontotherium*.

PROBABLY UPPER BEDS.

Symborodon torvus *Cope.* — Brachycephalic, incisors $\frac{0}{0}$, nasals thin, buccal processes of zygomata broad and flat, occipital pillars broad.

Symborodon acer *Cope* (Syn., *S. altirostris* Cope).—Dolichocephalic, nasals thicker, abbreviated. Horns of male long, recurved, low connecting crest, incisors vestigial.

MIDDLE AND UPPER BEDS.

Symborodon montanus *Marsh.*—Type in Yale Museum. Nasals thin, of medium length, upper incisors vestigial.

Two skulls in the National Museum (Nos. 4711, 4705) exhibit smaller canines than in Marsh's type, and possibly represent a fourth species, because the canines are exceptionally small, the nasals excessively thin, the horns elongate, set wide apart and very far back, oval in section at the top.

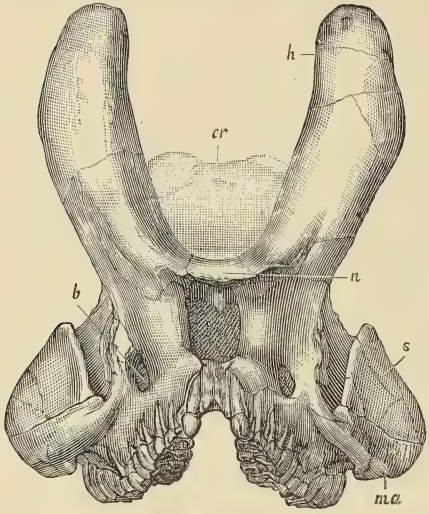

Fig. 8. *Symborodon? montanus* (Marsh). (U. S. Nat. Mus. No. 4711, Sk. V¹.)

Phylum IV.

Titanotheres attaining the largest size, with vertex of cranium greatly elongated by extension of horns in front of orbit and of occiput behind zygomata. Skull, however, as measured along the basal line and across the zygomata progressively brachycephalic. Horns transverse oval in section from base to summit, shifting forward and progressively elongating and flattening. Nasals abbreviating. Incisors $\frac{2}{2}$. *Canines stout, blunt, obtuse. Premolars* $\frac{4-3}{4-3}$, *cingulum degenerating.*

Genus BRONTOTHERIUM Marsh.

Syn., *Titanops* Marsh.

The type of this genus is the *Brontotherium gigas* jaw (Yale Museum), with which the type jaw of *Titanops elatus* (Yale Museum) is practically identical. The succeeding species (*B. curtum*, *B. ramosum*, *B. dolichoceras*, *B. platyceras*) of very long, flat-horned Titanotheres therefore belong to *Brontotherium*.

A discovery of great interest is a very primitive skull of

the same general type, but with rudimentary horns, in the Lower Beds, to which the name *B. leidyi* may be given. A

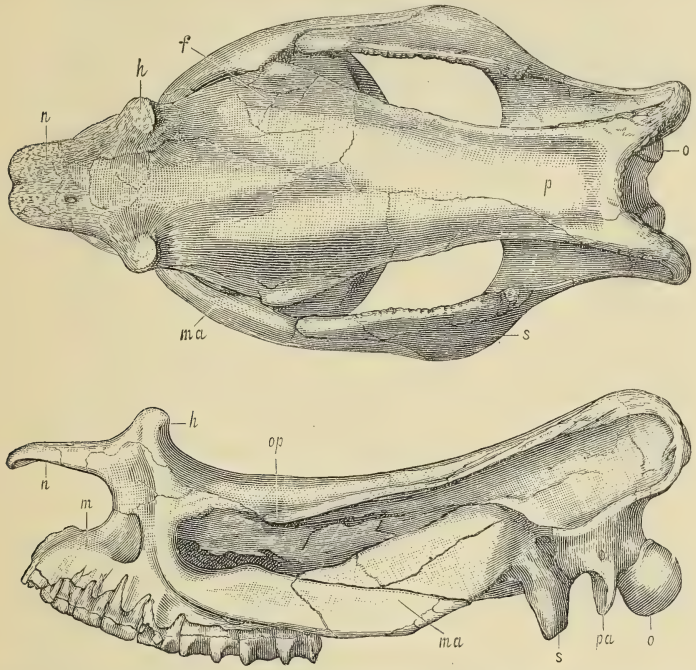

Fig. 9. *Brontotherium leidyi.* (U. S. Nat. Mus. No. 4249, Sk. R.) Type. × ⅛. The side view of this skull was figured by Marsh (Amer. Jour. Sci., Oct., 1887) as *Menops varians*

successor of this species from the Middle Beds proves to be identical with Cope's *Symborodon hypoceras*.

LOWER BEDS.

Brontotherium leidyi, sp. nov.

Type, Skull No. 4249, U. S. Nat. Mus. Nasals elongate, narrowing anteriorly. Horns very short, slightly recurved, of transverse oval section. Canines stout and blunt. Premolars non-cingulate, with rounded contours and well-developed tetartocones. Incisors $\frac{2-1}{-}$.

This rare skull was discovered by Hatcher and is positively recorded from the Lower Beds, Middle Level. It is

of exceptional importance because it is so clearly distinct from its contemporaries in the Lower Beds, namely, *Titanotherium heloceras* and *Megacerops brachycephalus*. It has numerous resemblances in the shape of the nasals, horns, canines, and back of the occiput to the great *Brontotherium* of the Upper Beds.

Fig. 10. *Brontotherium leidyi.* (U. S. Nat. Mus. No. 4249, Sk. R.) Type.

MIDDLE BEDS.

B. hypoceras *Cope.*—Cope's extremely fragmentary type of this species (No. 6361, Amer. Mus., Cope Coll.) is happily supplemented by two skulls found by Hatcher (Nos. 4702, 4273, U. S. Nat. Mus.), one of which is complete though crushed. These prove that this animal is undoubtedly a successor of *B. leidyi*, but separated by certain progressive characters, such as the more anterior position of the horns, and the entire loss of the median incisors.

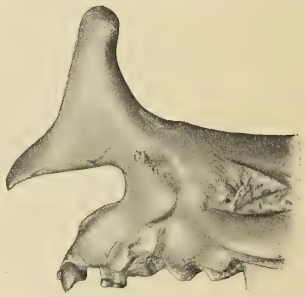

Fig. 11. *Brontotherium hypoceras.* (U. S. Nat. Mus. No. 4273), cotype.

Specific Characters.—Horns of medium length, transverse oval section; nasals shorter than in *B. leidyi;* zygomata with flattened buccal processes; incisors reduced to $\frac{1}{-}$.

This species, although exhibiting generic resemblances, is not ancestral to *B. gigas*.

UPPER BEDS.

The following species, beginning with *B. gigas*, form a closely related progressive series which is chiefly confined to the Upper Beds. One of the most distinctive characters is

the persistence of the large pair of upper incisors in all the male specimens thus far observed. Certain females apparently lack incisors. The horns are very long; the nasals gradually disappear.

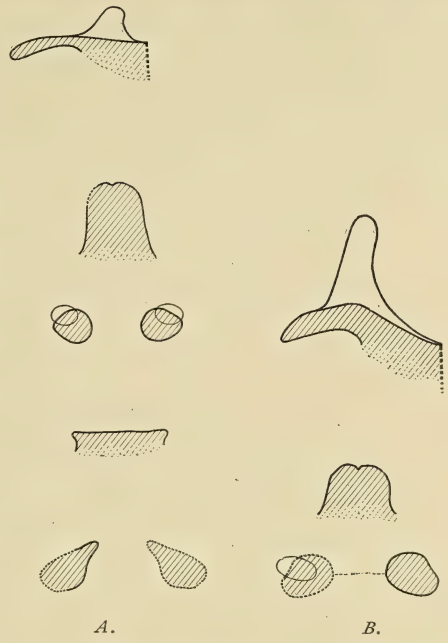

Fig. 12. Sections of nasals, horns, occiput, zygomata. *A*, *Brontotherium leidyi*, type. *B*, *Brontotherium hypoceras*, cotype.

B. bucco *Cope.*—In the writer's first review the type of this species was confused with the types of *Symborodon torvus*. It is actually represented by the posterior portion of a cranium in the American Museum (No. 6346). The buccal section of the zygomata is more convex than in the succeeding species.

B. gigas *Marsh.* (Syn., *Titanops elatus* Marsh).—This is now one of the best-known species, including the type in the Yale Museum, and numerous specimens in the American and National Museums previously referred to *B. elatum.*

Smaller and somewhat more primitive varieties of *B. gigas* are recorded by Hatcher from the Upper Levels of the Middle Beds.

B. dolichoceras *Scott & Osborn.* (Syn., *Titanops medius* Marsh).—Represented by types in the Harvard and National Museums. This species is intermediate in many characters between *B. gigas* and *B. curtum.*

B. curtum *Marsh.* (Syn., *Menodus peltoceras* Cope).—The type in the Yale Museum is supplemented by the female horns named by Cope *Menodus peltoceras*, also by

several specimens in the American, Harvard, and National Museums.

B. ramosum *Osborn.*—There is some question whether this is really distinguishable from *B. curtum.*

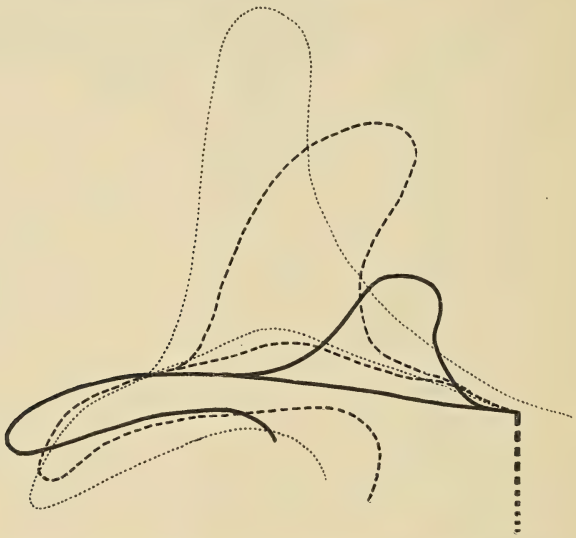

Fig. 13. Comparative fronto-nasal sections and horn contours. Showing progressive shifting forward of horns, and abbreviation of free portion of nasals. *Brontotherium leidyi*, Lower Beds. *Brontotherium hypoceras*, Middle Beds. (Nat. Mus. No. 4702.) *Brontotherium hypoceras.* (Nat. Mus. No. 4273.) The dotted vertical line shows the position of the orbit.

B. platyceras *Scott & Osborn.*—Type in the Harvard Museum.

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Article IX.—THE GENERIC AND SPECIFIC NAMES OF SOME OF THE OTARIIDÆ.[1]

By J. A. Allen.

The northern and southern Sea Lions, often known respectively as Steller's Sea Lion and Forster's Sea Lion, furnish an instructive illustration of the difficulties encountered in arriving at a fair knowledge of animals long known only from the vague accounts of explorers and travellers who, while eminent in other ways, are rarely good naturalists. Exact knowledge of the northern species dates from Steller (1751), whose classic memoir, 'De Bestiis Marinis,' forms a conspicuous landmark in the early history of mammalogy. In this both the Sea Lions and Sea Bears of Bering Sea were made known with admirable detail and clearness for this early period, and for nearly a century this memoir remained the chief source of information concerning them. Soon after Steller wrote, voyagers to the antarctic seas there met similar animals, but their accounts of them were vague and more or less erroneous. Steller's descriptions formed the basis of the introduction of these animals into the works of later systematists, his Sea Bear becoming the foundation of the *Phoca ursina* of Linnæus (1758), and his Sea Lion the principal basis of Schreber's *Phoca jubata* (1776). As their southern representatives became known they were identified by the naturalists of the day with Steller's species. Thus for half a century the histories of these antipodean forms were blended; there were only a single species of Sea Lion and only a single species of Sea Bear, each being regarded as common to the arctic and antarctic seas.

It was not till 1816 that Péron affirmed the specific distinctness of the northern and southern forms, and asserted

[1] In preparing a report on the Mammals of Patagonia for the 'Princeton University Reports on the Patagonian Expeditions of 1896–1899,' it has been necessary to consider the Pinnipeds of that region, an outcome of which is the discovery that the nomenclature of some of the species and genera is subject to correction. The present paper is an abstract of some of the results reached, the historical details on which the present rulings are based being reserved for later publication in full in the connection above stated.

that no species of animal was common to both these widely separated regions.

In the meantime a few specimens of the southern species, sometimes skulls without skins, sometimes skins without skulls, reached European museums, but it was not till about 1840 and later that specimens of the northern forms became in like manner available for investigation, and it was not till many years later that the real differences became known, when it was found that the northern and southern species were in no case even congeneric. Before this time, however, the names of numerous species had been added to the literature of zoölogy, based either on the very inadequate accounts of explorers, or on single specimens, often immature, and frequently from erroneously assigned or wholly unknown localities. Thus the nomenclature of the subject became so complicated and overburdened with synonyms that the task of unravelling of the tangled skein has scarcely yet been fully accomplished.

The Northern Sea Lion.

The Northern Sea Lion, or the *Eumetopias stelleri* of modern zoölogists, was first introduced into systematic zoölogy by Schreber[1] in 1776, under the name *Phoca jubata*, but he combined with it references to Pernetty's account of the Southern Sea Lion, and, as the only illustration of any Sea Lion available, copied Pernetty's wretched caricature of the southern species. Thus *Phoca jubata* was composite, though primarily based on Steller, and continued thus till 1816, when Péron[2] gave a new name to the southern species and retained, or 'restricted,' the name *jubata* to Steller's Sea Lion.[3] He also for the first time separated the eared seals from the earless seals, retaining the latter in the genus *Phoca* and establishing for the former a new genus *Otaria*. Lesson, in 1828,[4] in his reckless distribution of new names,

[1] Säug., III, 1776, p. 300.
[2] Voy. aux Terr. Austr., II, 1816, p. 40, footnote.
[3] *Op. cit.*, p. 35.
[4] Dict. class. d'Hist. Nat., XII, 1828, 420.

unrestrained by any rules of nomenclature, proposed for the Northern Sea Lion the name *Otaria stelleri*, under which specific name it has since been currently recognized. Its proper name, however, as shown by the following citations, is *Eumetopias jubata* (Schreber).

Eumetopias jubata (*Schreber*).

Phoca jubata Schreber, Säug. III, 1776, 300. Sea Lion of Steller, mainly; not the plate (pl. lxxxiii), nor the references to Pernetty.
Otaria jubata Péron, Voy. aux Terr. Austr. II, 1816, 35, 53, referring exclusively to the Sea Lion of Steller.
Eumetopias jubata Allen, MSS. (in Reports of the Princeton University Expeditions to Patagonia, 1896–1899, Mammalia).
Otaria stelleri Lesson, Dict. class. d'Hist. Nat. XIII, 1828, 420.
Eumetopias stelleri Gray, Ann. & Mag. Nat. Hist. 3d Ser. XVIII, 1866, 233; and of most subsequent authors.

The Southern Sea Lion.

At the time Péron restricted the name *Otaria jubata* to the Sea Lion of Steller, he imposed upon the Southern Sea Lion the name *Otaria leonina*, leaving no doubt of his intention to separate the two species and to restrict the name *jubata* to the northern one.

Unfortunately, however, his name *leonina* for the southern species is unavailable, on account of Molina having given, long before (1782), the name *Phoca leonina* to the same species, a name Linnæus had previously given (in 1758) to the Elephant Seal, or Sea Lion of Anson, a wholly different animal. It is therefore necessary to select from the later-given names the first that is unequivocably referable to the Southern Sea Lion, and in all other respects tenable. This proves to be *Phoca byronia* of Blainville, based exclusively on the skull of a Sea Lion said to have been brought by Commodore Byron from the Island of Tinian, one of the Mariana or Ladrone group, but which there is good reason to believe came either from the Straits of Magellan or from Juan Fernandez Island, both of which places were visited by Commodore Byron on the same voyage. That it could not

have come from the Island of Tinian is beyond question, since the Mariana Islands are far away from the range of any known species of Pinniped. There is, further, no doubt as to this skull being referable to the Southern Sea Lion, the *Otaria jubata* of most modern authors, it being not only identifiable as such from Blainville's description and figure of it, but, being still extant in the Museum of the College of Surgeons of London, has repeatedly been examined and identified as such by competent authorities.

There are many later names applicable to this animal, but none earlier that are entitled to recognition. As already stated, Péron's name *leonina*,—a natural and very proper designation, and one which for many years was currently applied to it,—is preoccupied and unavailable.

The *Phoca porcina* of Molina (1782) is recognizable merely as an eared seal, but whether referable to *Otaria* or *Arctocephalus* cannot be determined from Molina's very imperfect account of it.

The *Phoca longicollis* of Shaw (1800), based on the Long-necked Seal of Grew and Parsons, formerly in the Museum of the Royal Society of London, from an unknown locality, is not identifiable, beyond its being a young eared seal. It was referred by Gray, at different times, to *Otaria leonina* and to *Arctocephalus falklandicus*, as he thought it more likely to have come from southern South America than elsewhere.

Phoca flavescens Shaw (1800) was based on a young eared seal in the Leverian Museum, described by Pennant, said to have come from the Straits of Magellan. It was only about two feet long, and described so imperfectly that it can only be identified as a young eared seal.

The principal synonymy of the Southern Sea Lion may be given as follows:

Otaria byronia (*Blainville*).

Phoca jubata Schreber, Säug. III, 1776, 300, pl. lxxxiii. In part; only in so far as it relates to the Sea Lion of Pernetty.
Otaria jubata Desmarest, Mamm. I, 1820, 248, in part only.

Otaria jubata Peters, Monatsb. Akad. Berlin, 1866, 263. Also of both Peters and Gray subsequently, and of most later writers.
Phoca leonina Molina, Sag. Stor. Nat. Chili, 1782,—not of Linnæus.
Otaria leonina Péron, Voy. aux Terr. Austr. II, 1816, 40, 65. Not *Phoca leonina* of Linnæus.
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Otaria pernettyi Lesson, Dict. class. d'Hist. Nat. XIII, 1828, 420.
Otaria chilensis Müller, Arch. f. Naturg. 1841, i, 333.
Otaria ulloæ Tschudi, Fauna Peruana, Mamm. 1844–46, 136, pl. vi. Also of Peters, 1866.
Otaria godeffroyi Peters, Monatsb. Akad. Berlin, 1866, 264, pl. i.
Otaria minor Gray, Ann. & Mag. Nat. Hist. 4th ser. XIII, 1874, 326.
Otaria pygmæa Gray, *ibid.* 326.

The Generic Name of the Northern Fur Seals.

On the reception by Gray in 1859 of a skull of a northern Fur Seal he found that, as he had supposed previously, it was not only specifically distinct from all the southern Fur Seals, but represented a new genus, which he named *Callorhinus*. This name was found later by Dr. T. S. Palmer to be preoccupied, and he proposed in its place the name *Callotaria*.[1] Still later [2] he believed he had found an earlier name for the group in *Otoes* G. Fischer (1817).[3] An examination, however, of Fischer's name leads me to a different conclusion from that reached by Dr. Palmer, so that in my opinion *Callotaria* Palmer (1892) is the proper name for the group. Fischer, evidently ignorant that Péron had already (in the preceding year) given the generic name *Otaria* to the Eared Seals, proposed for them the name *Otoes*, based on G. Cuvier's

[1] Proc. Biol. Soc. Washington, VII, p. 159, July 27, 1892.
[2] Proc. Biol Soc. Washington, XIV, p. 133, Aug. 9, 1901.
[3] Mém. Soc. Imp. des Nat. de Moscow, V, 1877, p. 445.

group "Les Phoques à oreilles extérieures," or "Otaries de Péron," [1] Cuvier neglecting to use Péron's name in its Latin form. Fischer's diagnosis is an abridged paraphrase of Cuvier's, even to the inclusion of Cuvier's ambiguous statement respecting the number of incisors; he cites as referable to *Otoes* "Phoca jubata, ursina, Lin. Gmel.,"—in other words, the Sea Lions (*Phoca jubata* auct.) and the Sea Bears (*Phoca ursina* auct.) as recognized by Cuvier, and as known to the naturalists of that day, who all, except Péron, believed there was only one species of each, common alike to the arctic and antarctic regions. Even as late as 1823 G. Cuvier [2] spoke derisively of Péron's assumption that none of the Seals of the "hémisphère antarctique" were "de même espèce que ceux du nord."

It consequently happens that the genus *Otoes* Fischer, 1817, is an exact synonym of *Otaria* Péron, 1816. Dr. Palmer's conclusion to the contrary is based on a misapprehension of the case, through evident lack of familiarity with the complicated history of the group in question, as shown by his statement of the case, namely: "*Phoca jubata* Gmelin is a composite species based in part on a southern fur seal [*lege*, southern sea lion] and in part on the northern sea lion. . . . The name had been, however, previously applied by Forster in 1775, and is now generally restricted to the southern fur seal [*lege*, southern sea lion]. *Phoca ursina* Gmelin (*P. ursina* Linn.) is the northern fur seal of Bering Sea and, as the only identifiable species in the group [*Otoes*], may be considered as the type of *Otoes*. . . . What he [Fischer] did was simply to apply a generic name to Cuvier's group which, as shown above, was based chiefly on the northern and not on the southern fur seal."

As regards the above, (1) the components of *Phoca jubata* Gmelin (which, however, is Schreber's species) are perfectly identifiable (as shown above, p. 112), and are equivalent to the genera *Otaria* and *Eumetopias* as now currently restricted,

[1] Règne Animal, I, 1817, p. 166.
[2] Ossem. foss., V, 1823, p. 218.

and thus had nothing to do with any "southern fur seal." (2) The name *Phoca jubata* has been attributed by various authors, at different times, to "Forster, 1775," but I am unable to find that he ever used at this date any terms for the eared seals other than sea lion and sea bear. In accordance with the belief of his time, he supposed there was only one species of each, and that both were common to both the arctic and antarctic regions. In his posthumous work, 'Descriptiones Animalium,' brought out by Lichtenstein in 1844, he used the Latin terms *Phoca jubata* and *Phoca ursina* in just this sense; but the only members of the group he knew personally were the southern species; the "*Phoca ursina*" he described, and transmitted the drawing of to Buffon, and which Buffon published, was the Sea Bear of New Zealand, *Arctocephalus forsteri* (Lesson) of modern writers. (3) Cuvier's *Phoca ursina*, instead of being "the only identifiable species in the group," is composite, to the extent even of embracing three perfectly identifiable species of Fur Seal, and a fourth species that was probably a young *Otaria*, but which is not positively identifiable. These are (*a*) the Sea Bear of Steller; (*b*) the Fur Seal of the Cape of Good Hope ("*Phoca pusilla*"); (*c*) *Arctocephalus forsteri*, the species figured in Buffon's plate cited by Cuvier; and (*d*) the *Phoca flavescens* Shaw, not satisfactorily identifiable. The plate cited by Cuvier ("Buff., Suppl. VII [*lege* VI], pl. xlvii") Buffon states is from a drawing sent him by Forster, which, as those familiar with the literature of the subject know, relates to the Fur Seal of New Zealand, having been made at Dusky Bay, on the southeast coast of South Island, New Zealand, March 31, 1773.[1]

It is thus clear that *Otoes* is unavailable for the *Callotaria* group, since if one name can ever be considered as a synonym of another, it is evident that *Otoes* and *Otaria* hold such a relation.

The synonymy of *Callotaria* will stand as follows:

[1] *Cf.* Forster, Descrip. Anim., p. 64; Forster's Voyage Round the World, I, 1777, p. 151; Buffon, Hist. Nat. Suppl., VI, 1782, pp. 330, *et seq.*

Genus **Callotaria** *Palmer.*

Phoca and *Otaria*, in part, of early authors.

Callorhinus Gray, P. Z. S. 1859, 359. Type "*Arctocephalus ursinus* Gray" = *Phoca ursina* Linn. Preoccupied by *Callirhinus* Blanchard, 1850, for a genus of Coleoptera.

Arctocephalus Gill, Proc. Essex Inst. V, 1866, 7, 11. Type, "*Phoca ursina* Linn." Not *Arctocephalus* F. Cuvier, 1824.

Callotaria T. S. Palmer, Proc. Biol. Soc. Washington, VII, 1892, 156; July 27, 1892. To replace *Callorhinus* Gray, preoccupied.

Otoes T. S. Palmer, Proc. Biol. Soc. Washington, XIV, 1901, 133; Aug. 9, 1901. To replace *Callotaria* Palmer. Not *Otoes* G. Fischer, 1817 = *Otaria* Péron.

Article X. — A NEW CARIBOU FROM THE ALASKA PENINSULA.

By J. A. Allen.

One of the results of the past season's work of the Andrew J. Stone Expedition is the discovery by Mr. Stone of a new form of Caribou on the Alaska Peninsula. The greater part of the season of 1901 was spent in further exploration of Kenai Peninsula, to complete the work begun there by Mr. Stone during the autumn of 1900, where he obtained a specimen of the new Caribou since described as *Rangifer stonei*.[1]

Mr. Stone's familiarity with the large game of the far North had led him to anticipate that the form of Caribou inhabiting the Alaska Peninsula,—the most western portion of the mainland of Alaska, and extending several hundred miles beyond the western limit of tree growth,—would prove of especial interest, and at the close of the season of 1901 he left Homer, on Kenai Peninsula, for the express purpose of securing a good series of specimens of this animal. The journey of nearly 1000 miles was made during the latter part of October, when the season was far advanced and navigation dangerous, but the opportunity seemed too favorable, on account of his comparative nearness to the locality, to forego the chances of the trip. The departure from Homer was made on the 15th of October, and Sand Point, Popoff Island, was reached by steamer four days later, but owing to continuous storms it was impossible to cross to the mainland, only twelve miles distant, till October 26, and it still required two days more to reach the point on the coast, some twenty miles distant, which had been selected as the field of operations. The first day's hunt, on October 29, was rewarded by the capture of nine head of Caribou, and others were taken later, until fifteen fine specimens had been secured.

These specimens, taken October 30 to November 9, are very uniform in their general characters, and differ from the

[1] This Bulletin, Vol. XIV, 1901, pp. 143–148.

Fig. 1. *Rangifer granti.* No. 17601, ♂ ad., Alaska Peninsula. Andrew J. Stone Expedition. ¼ nat. size.

other forms of Caribou known from North America in various external features and in many cranial peculiarities

In view of the important services rendered by Mr. Madison Grant, Secretary of the New York Zoölogical Society, in securing funds for the organization and maintenance of the

Fig. 2. *Rangifer granti.* Same specimen as Fig. 1. About $\frac{1}{10}$ nat. size.

Andrew J. Stone Expedition, and in recognition of his well-known interest in securing specimens of the game animals of North America for exhibition and for scientific research, this new and very interesting type of Caribou may be fittingly named

Rangifer granti, sp. nov.

Type, No. 17593, ♂ ad., western end of Alaska Peninsula, opposite Popoff Island, Oct. 29, 1901; Andrew J. Stone Expedition.

Adult male, end of October. — General color above dark brown; rump patch white; on lower parts of flanks a broad whitish band behind the shoulder, rapidly narrowing posteriorly and becoming lost in the general coloration; below this a dark lateral band, separating the dark color of the sides from the white ventral surface; top of shoulders and sides of neck light gray, strongly tinged with cream-white, the tips of the hairs yellowish gray, the basal two-thirds dark gray; long hair on median ventral line of neck yellowish white, not greatly lengthened as in *R. stonei;* muzzle, chin and edges of lips silvery grayish white; whole top of nose very dark brown or blackish brown, becoming lighter posteriorly; sides of head lighter brown, passing into paler yellowish brown on sides of throat, and into yellowish white on the median line; fore neck (except median line) yellowish, the tips of the hairs darker, yellowish gray-brown; pectoral area very dark brown, nearly as dark as the top of the nose; whole ventral surface yellowish white, becoming nearly pure white posteriorly and on the inside of the thighs; front of fore

Fig. 3. *Rangifer granti.* ♂ ad. Same specimen as Fig. 1. About ⅓ nat. size.

limbs dark brown, sides lighter, posterior surface nearly white, forming a narrow longitudinal stripe; hind legs similarly marked but less dark on the outer surface; a narrow line of yellowish white borders the hoofs of both fore and hind feet; tail white, with a dark band continued from the back through the white rump patch onto its upper surface.

Adult Female, end of October. — Considerably lighter throughout than the male, the back and sides broccoli brown, and the dark parts of the face and the pectoral area lighter than in the male.

Young.—A six-months old calf (female) has the general coloration creamy white, clearer white on the ventral surface. The dark areas seen in adults are veiled by the long yellowish white tips of the hairs, being barely indicated as a darker shade showing through the surface on the legs, front of the head and over the middle portion of the back. In general color effect this specimen closely resembles the summer coat of the White Sheep (*Ovis dalli*). It retains its spike antlers, which are still in the velvet, and are black instead of grayish brown, as are those of *R. caribou* and *R. terræ-novæ* at a corresponding stage.

Fig. 4. *Rangifer granti*. No. 17595, ♀ ad., Alaska Peninsula. Andrew J. Stone Expedition. $\frac{1}{6}$ nat. size.

A young male of the same age resembles the young female except in being somewhat darker, with the incipient dark areas more strongly outlined. These two young specimens were with their mothers when killed and evidently were not yet weaned, the udders of the old females being full of milk.

The adult male above described as the type is the darkest of the

whole series, other males of corresponding age having the dark parts of the body, limbs and head much paler, nearly as in the above described female. The series of four adult males ranges in the color of the dark parts from clove brown to broccoli brown, the variation in color being doubtless due to the seasonal condition of the pelage, the lighter coat being probably a more advanced stage toward the full winter coat.

Measurements. — The collector's measurements given below, taken from the freshly killed specimens before skinning, indicate the very small size of this animal as compared with any of the woodland species, and the great length of the tail vertebræ, which averages 192 mm. in the five males as against 152 in a corresponding series of males of *R. montanus*, notwithstanding the fact that the latter is a very much larger animal. The height of the males at the shoulders is also some 200 mm. less in *R. granti* than in *R. montanus*.

Fig. 5. *Rangifer granti*, ♀ ad. Same specimen as Fig. 4. $\frac{1}{5}$ nat. size.

Skull. — In size the skull most resembles that of *R. grœnlandicus* (*R. arcticus* is not available for comparison), but the antlers, while light and slender, are about one third shorter in the length of the main beam, and the brow antlers and principal branches are proportionately reduced. The skull is rather smaller than in *R. grœnlandicus*, with relatively much longer nasals, which average 122 mm. in a series of four males as against 112 mm. in two males of *R. grœnlandicus*, the basal length of the skull averaging the same in both species. The skull differs from

that of *R. stonei*, geographically its nearest neighbor, in its strikingly small size, the mastoid breadth being 128 mm. in the former and 158 mm. in the latter, with all that this implies in respect to the general size. Notwithstanding this, the nasal bones are as long in *R. granti* as in *R. stonei*, while the relative length of the intermaxillaries is greatly reduced in *R. granti*, giving very different proportions to the parts that enter into the rostral portion of the skull. The antlers in the two forms are also strikingly different, as regards size and weight, and especially in the form of the brow antlers. As regards cranial characters no comparison is necessary with *R. montanus* or with any of the woodland forms.

External Measurements.

	17589 ♂ ad.	17590 ♂ ad.	17591 ♂ ad.	17593 ♂ ad.	17600 ♂ ad.	17594 ♀ ad.	17595 ♀ ad.	17599 ♂ juv.	17596 ♀ juv
Total length	1880	1778	1727	1880	1905	1664	1651	1397	1574
Tail vertebræ	190	190	190	203	191	165	165	140	152
Length of hind foot (tarsus and foot)	559	569	546	572	584	533	521	470	495
Length of fore foot (carpus and foot)	686	686	724	724	724	635	635	572	597
Height at shoulder	1118	1118	992	1095	1245	929	903	953	902
Head of humerus to head of femur	916	864	864	941	916	483	864	762	813
Width of chest	267	254	241	279	305	229	241	203	229

Measurements of Skulls.

	17601 ♂ ad	17503 ♂ ad	17598 ♂ ad	17600 ♂ ad	17589 ♂ ad	17595 ♀ ad
Basal length	375	364	370	370	350	310
Tip of premaxillæ to tip of nasal	100	107	99	93	89	75
" " " " alveolus of p^1	120	117	124	116	109	102
Length of nasals	119	123	126	118	124	109
Breadth above m^2	117	107	113	109	109	98
Zygomatic breadth	138	141	141	134	133	122
Greatest breadth at orbits	167	169	166	154	161	149
Mastoid breadth	128	135	131	111	117	95
Palatal breadth at m^1	63	61	64	61	62	56
Upper toothrow, crown surface	103	102	96	104	101	92
Distance between antlers below the burr	64	56	60	61	48	56
Length of mandible, incisive border to angle	294	300	292	290	266	247
Angle to tip of coronoid	130	130	135	130	130	115
Depth at m^2	38	33	33	35	37	35
Length of lower toothrow	108	102	100	103	108	96
Diastema	106	102	106	108	108	98
Antlers, main beam to tip, along curvature	860	850	1010	780	820	364
" greatest spread at point of palmation	890	775	815	685	640	275
" distance between tips of longest tines	810	683	...	685	545	...
" " " points at tip of main beam	810	685	720	600	450	210

Rangifer granti is a representative of the Barren Ground group of Caribou, which includes *R. arcticus* of the Arctic Coast and *R. grœnlandicus* of Greenland. It is not closely related to *R. stonei* of the Kenai Peninsula, from which it differs not only in its very much smaller size, but in important cranial characters and in coloration. *R. stonei* was described[1] from a single fine head (including both skin and skull), collected by Mr. Stone on the Kenai Peninsula in 1900. This single incomplete specimen was insufficient to show the very strong differences that obtain between *R. stonei* and *R. montanus*. Mr. D. G. Elliot has since given a full description of the same species [2] from a mounted specimen collected by Mr. H. E. Lee, on Kenai Peninsula September 5, 1898. Mr. Lee's specimen shows the same type of antlers, with the brow antlers very heavily developed, and distinctive features of coloration, including the absence of a caudal patch, so strongly and uniformly developed in *R.*

Fig. 6. *Rangifer granti*, ♀ ad. Same specimen as Fig. 4. About ⅓ nat. size.

[1] This Bulletin, Vol. XIV, 1901, pp. 143–148, fig. 1–4.
[2] Publications Field Columbian Museum, Zoöl. Ser., III, No. 5, pp. 59–62, pl. xi–xiii.

granti. The external and cranial differences between *R. granti* and the various forms of the Woodland Caribou are so great in almost every respect that no detailed comparison is necessary.

According to Mr. Stone, *Rangifer granti* inhabits the "barren land of Alaska Peninsula, ranging well up into the mountains in summer, but descending to the lower levels in winter, generally feeding on the low flat lands near the coast and in the foothills. They formerly lived in considerable numbers on Unga Island, where they are now practically extinct. The only other island inhabited by them is Unimak Island, at the western end of the Alaska Peninsula. They were formerly exceedingly abundant, but they have been of late greatly reduced in numbers through the agency of market hunters."

The habitat of *R. granti* is thus an isolated area occupying the treeless portion of the Alaska Peninsula and (formerly at least) some of the immediately adjoining islands at the extreme western end of the peninsula.

Article XI. — A SKULL OF DINOCYON FROM THE MIOCENE OF TEXAS.

By W. D. Matthew.

Among the valuable specimens brought back by Mr. J. W. Gidley from his collecting trip for the American Museum last summer, were the skull and part of the skeleton of an enormous carnivore which on extraction from its matrix proves to be a Canid of the Amphicyonine group. It appears to be a very aberrant species of *Dinocyon*, a genus hitherto known by teeth and fragments of the jaw of *D. thenardi* described by

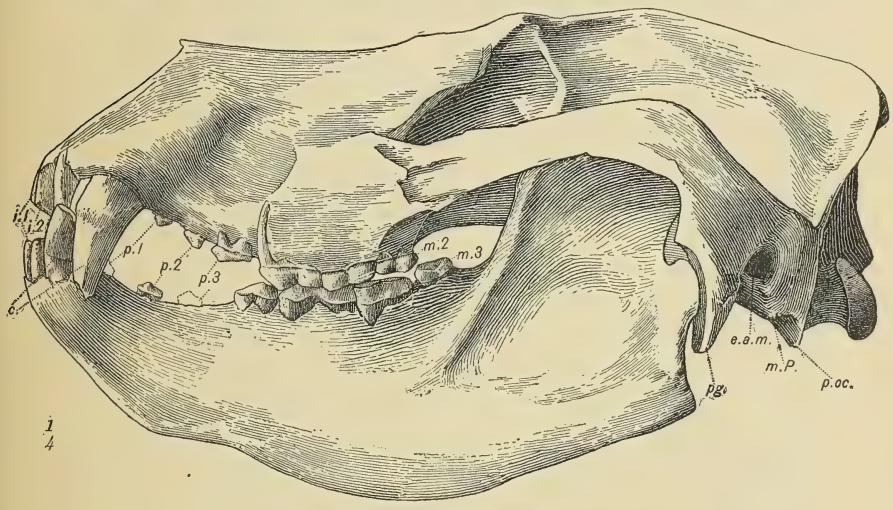


Fig. 1. Side View of Skull × ¼.

Jourdan in 1862[1] from the Upper Miocene beds of Grive St.-Alban.

This specimen is more complete than any Amphicyonine hitherto described, not only in this country, but in Europe, where Amphicyons have long been known. The skull and

[1] Comptes Rendus de l'Institut, LIII; Bull. des Sociétés savantes (1862). Another species, *Amphicyon göriachensis* Toula, is referred to this genus by Prof. Deperet. Dr. Schlosser prefers to place it with *Hemicyon*, probably identical with *H. sansaniensis* Lartet. It would seem to be an intermediate form, like *Dinocyon* in the carnassial, like *Hemicyon* in the tuberculars.

jaws are complete although crushed, and the first eight vertebræ are in place. The succeeding nine vertebræ and parts of the hind limb were found close by. All were enveloped in hard flinty concretion, which has been removed from one side only of the specimen. The horizon is the Loup Fork terrane, which, in the part of Texas in which this specimen was found, contains a fauna approximately Upper Miocene in age so far as comparisons have been instituted.

It is only within the past two years that true Amphicyons have been recognized in this country, the species referred to that genus by Leidy and Cope being, as Prof. Scott has shown,[1] much more primitive, and nearly or quite in the line of descent of the modern Canidæ, while the true Amphicyons are an aberrant branch of dogs, related to the Ursidæ, but not directly ancestral to them, according to Dr. Schlosser's recent studies on the group.[2] In the 'American Journal of Science' for January, 1901, however, Dr. Wortman has described a true *Amphicyon* from the Loup Fork beds of Nebraska. Mr. Earl Douglas has recognized the genus in the same terrane in Montana. The American Museum Expeditions of 1901 obtained remains of Amphicyons both in the older Loup Fork of Colorado (Middle Miocene) and the newer Loup Fork of Texas (Upper Miocene). To this group may also be referred three species of Canidæ described some time since, but whose position has not been recognized. These are:

Canis (*Ælurodon*) *ursinus* Cope,[3] from the Loup Fork of New Mexico.

Borophagus diversidens Cope,[4] from the Blanco of Texas.

Ælurodon mæandrinus Hatcher,[5] from the Loup Fork of Kansas.

The specimen here described represents a species distinct from any of those above mentioned, and is named in honor

[1] Notes on the Canidæ of the White River Oligocene, Trans. Amer. Phil. Soc., Vol. XIX, 1898, p. 326 *et seq.*

[2] Ueber die Bären und bärenähnlichen Formen des europäischen Tertiärs. Palæontographica, Bd. XLVI, 1899, p. 95 *et seq.*

[3] Proc. Acad. Nat. Sci. Phila., 1875, p. 256; Rep. Wheeler Survey, 1877, p. 304, pl. lxix, fig. 1.

[4] American Naturalist, 1892, p. 1028; Rep. Tex. Geol. Sur., 1892, p. 52, pl. xiii, fig. 4.

[5] American Naturalist, 1894, p. 239 and fig.

of Mr. J. W. Gidley, the discoverer of many of the choicest specimens of fossil mammals in the collections of the American Museum and of Princeton University.

Dinocyon (?Borophagus) gidleyi, sp. nov.

Generic and Subfamily Characters. — Dentition, $\frac{3.1.4.2}{2.1.?\,4.3}$. Premolars much reduced, without posterior accessory cusps, one or two of the inferior series perhaps absent. Carnassials small and low with reduced shear, tubercular teeth very large with low cusps. Jaw very deep and massive, facial part of skull elongated, sagittal and occipital crests high, brain-case small. Bullæ inflated, but smaller than in typical Canidæ, mastoid process small, paroccipital process moderately long, coössified with the bulla. (In the bears the mastoid process is much enlarged, the paroccipital reduced, and the tympanic bulla not inflated.)

Subgeneric Characters.—Teeth like those of *Amphicyon* in form, especially such species as *A. americanus* Wortman. Upper molars much wider transversely, and the first more trigonal in outline than in *Dinocyon thenardi.*

Specific Characters.—Size somewhat greater than in *D. thenardi* or *D.* ("*Aelurodon*") *mœandrinus*, premolars more reduced and premolar region of the jaw longer than in the latter species or in *Borophagus diversidens.*

It is difficult to place this fine species in any of the described genera. In form and character the carnassials and molars (Fig. 2) are like those of *Amphicyon.* But the third upper molar, a well developed tooth in *Amphicyon*, is absent from either side of the Texas skull, as it is in *Dinocyon* and *Hemicyon*, and probably in *Pseudamphicyon.*[1] The size is near that of *D. thenardi*, with which the proportions of the lower teeth, so far as they can be seen, agree fairly well. But the first and to some extent the second upper molars, are trigonal and much extended transversely, while in *Dinocyon*, and still more in *Hemicyon*,

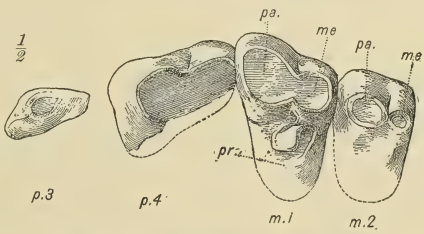


Fig. 2. Crown View of Teeth × ½.

[1] Schlosser, *l. c.*

these teeth approach the round quadrate shape characteristic of *Hyænarctos*. *D. gidleyi* may be considered as an aberrant member of the genus *Dinocyon*, but its relationship to the type species is perhaps rather formal than real.[1]

The skull (Fig. 1) is the most complete one yet described of an Amphicyonine dog. Professor Filhol[2] has described and figured a skull of *A. lemanensis*, but it was by no means complete. The Texas skull, although crushed, is quite complete, and the parts of the skeleton preserved enable us to determine the proportions and general character of this great carnivore.

The size of the skull equals or exceeds that of any living carnivore of which I can find record. It is longer, wider, and deeper than the largest *Ursus maritimus* skull in our collection, and its measurements slightly exceed those given for the Kadiak bear in length and depth (including the jaw). The crushing of the skull prevents any exact comparison in width; but the Kadiak skull is probably much wider than was that of *D. gidleyi*.

The most striking characters of the skull are the size and depth of the jaw, and the heavy zygomatic arches. The nasal openings are large and cavernous, as in the polar bear, unlike the smaller and more slender muzzle of the lesser bears and of the dogs. The inferior postorbital process is hardly as prominent as in the wolf, much less than in any of the bears. The tympanic bullæ are inflated, although of proportionately smaller size than in the wolf. The teeth are larger in proportion to the size of the skull than in the bears, especially the molars, which exceed those of *U. maritimus* in length and are more than twice as wide. The cranium bears a high crest, as in *Amphicyon*, giving attachment for the powerful jaw-muscles; and the brain is decidedly smaller than in the modern Ursidæ. Compared with *Amphicyon*

[1] Should further study of the American Amphicyons render it advisable to remove *D. gidleyi* and the probably nearly allied *D. mæandrinus* to a different genus, Cope's name *Borophagus* may perhaps be used. But as the type of *Borophagus* is from the Blanco beds it would be desirable to know more than we do at present about the Blanco Amphicyons before making any such change. All that can be said at present is that there were two or more species of the group in this horizon, of unknown dental formula.

[2] Arch. Mus. Lyons, III, 1883, pl. i, figs. 3–5.

lemanensis of the Upper Oligocene, the premolars are more reduced, the muzzle larger, the sagittal crest not so high, and the brain-case fully as large in proportion (although, as the skull is so much larger, one would expect to see a proportionately smaller brain-case). The arches are heavier and the jaw much deeper. In the outline sketch of the skull (Fig. 3) the crushing of the specimen has been corrected, as nearly as could be estimated.

The cervical vertebræ are of the size of those of the polar bear, but differ rather widely from both bears and modern

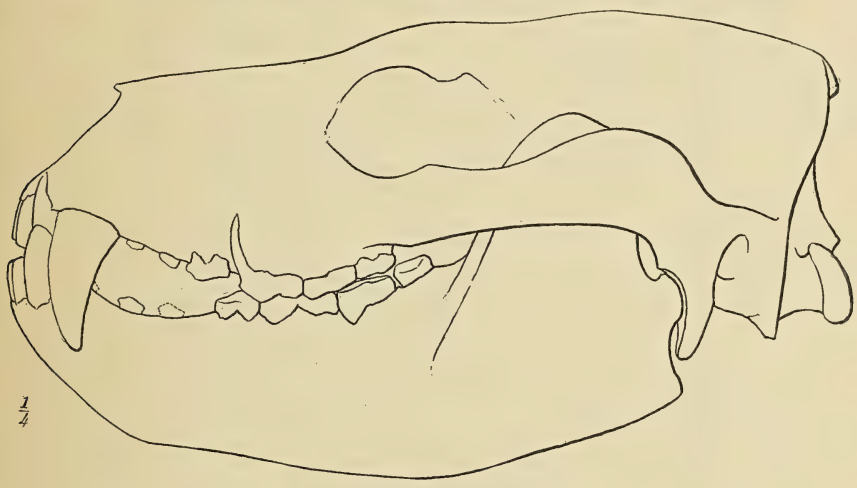


Fig. 3. Outlines of skull restored × ¼.

Canidæ, suggesting some of the more primitive Canidæ, such as *Daphænus*. The *atlas* is not very perfectly preserved, and does not show any very significant characters. The *axis* is not unlike that of the bears, the spine ending posteriorly in a short heavy process directed equally upward and backward. The anterior prolongation of the spine as a thin high lamina, carried far forward in the dogs and still further in the cats, is much reduced, as it is in the Ursidæ. The hæmal surface of the centrum bears a strong median ridge. The remaining *cervicals* bear spines of much greater height than in *Canis* or *Ursus*, and of quite different form; they are flat, slender at

the base, and carry a nearly uniform width to the tip, where they are slightly enlarged. This form of spine in the cervicals, resembling the usual form of a dorsal spine, is seen to a less extent in *Daphœnus*, but not in any of the large modern carnivora, among which the bears offer the nearest approach. The zygapophyses are considerably smaller than in *U. maritimus;* the transverse processes are as long, but quite slender,—their inferior lamellæ quite well developed on the one or two vertebræ in which they have not been broken off.

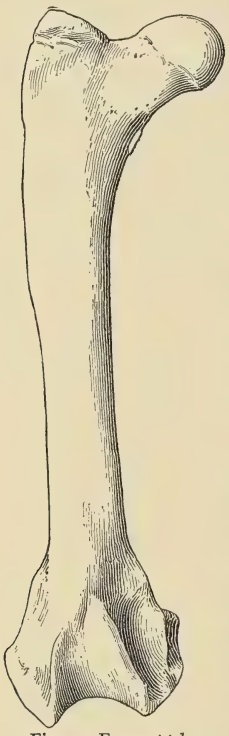


Fig. 4. Femur × ¼.

The centra of probably the first nine *dorsals* are preserved, of which the first was found in position. They are somewhat narrower and a little longer than in *U. maritimus;* the first three are strongly keeled, the others are round inferiorly, as in the bear. No part of the arches or spines is preserved.

The *femur* (Fig. 4) is smaller than that of *U. maritimus*, and resembles much more that of the wolf in its characters. The ball faces more laterally than in the bears, and is well to one side of the axis of the shaft; the shaft is somewhat curved, less so than in *Canis*, much more than in *Ursus;* the condyles project more posteriorly, the trochlea is narrow and deep, as in the wolf, not broad and shallow as in the bear. The lesser trochanter appears to be less prominent than in either *Canis* or *Ursus;* the greater trochanter projects to a level with the top of the ball, and is considerably more prominent than in *Ursus*.

The upper end of the tibia is preserved, but considerably crushed. It appears to have the high cnemial crest and narrow proximal facets of the dog, not the lower crest and broad facets of the bear.

Nothing is preserved of the feet, an unfortunate defect, for

the best generic distinction between *Dinocyon* and *Hemicyon* lies in the foot characters, the former genus being plantigrade with short metapodials like the bears, the latter digitigrade with long metapodials like the dogs.[1] If indeed the closer resemblance to the Canidæ which we find in the femur and tibia of *D. gidleyi* is equally marked in the distal parts of the limbs, then our species is not related to *Dinocyon*, but must be placed in a distinct genus allied to *Hemicyon*.

Measurements.	D. gidleyi.	D. thenardi.	A. lemanensis.	U. maritimus.	D. mæandrinus Type spm.	D. mæandrinus Texas spm.
Length of skull, incisors to occipital crest	450		323	397		
Length of upper dentition (i^2–m^2 in *Dinocyon* and *Ursus*)	204		144	147		
Length of upper p^4–m^2	79		52	64		
" " " p^4 longit	34		17	16		
" " " m^1 "	26	33	15	19		
" " " m^2 "	21	29	13	27		
Width " " m^2 transverse....est.	32	33	18	15		
" " " m^1 " ....est.	40	34	19	13		
" " " p^4 "	22		12	8		
Length of jaw	363			252		
Depth " " beneath p_4	82			50	55	69
" " " " m_2	103			50		
Post-canine diastema (c_1–p_4 exclusive)						
Length p_4–m^3	101			76		
" m_1	40	45		25	47	47
" m_2	31	32		21		24
" m_3	17	19		17		
Width of skull (as crushed)	270		180	197		
Length of seven cervical vertebræ	347			330		
Width of centra of same, average	44			46		
Length of ten dorsal vertebræ	398			345		
Average width of centra	39			40		
Length of femur	391			438		
Least diameter of shaft	32			34		
Diameter of distal end	87			98		
" " ball	46			56		

Although more specialized than *Amphicyon*, *D. gidleyi* is apparently not nearer to the bears; the characters of the

[1] Filhol, Mammifères fossiles de Sansan, p. 151.

femur are considerably less bear-like than in *A. major*, judging from Filhol's description and figures;[1] the vertebræ are bear-like in many respects, but quite peculiar in the length and form of the spines. The skull and teeth suggest an independent specialization, parallelling that of the bears in a few characters, but in most respects peculiar. A further discussion of its relationship is reserved for a later paper.

The animal must have been of peculiar appearance, not greatly resembling either bears or dogs. The enormous head was carried very low (if this is the correct interpretation of the high cervical spines), more so than in the bears, much more than in the wolves; the muzzle was long and heavy; the contour of the head was straight, and continuous with the neck; the ears of moderate size, jaw very long and deep, wide gaping, cheeks rather wide. The neck was as massive as in *U. maritimus*, the trunk longer and slimmer, the legs shorter, sharply flexed at the knees, the thigh not as free from the trunk as in Ursidæ, but much more like the condition seen in the Canidæ.

[1] Mammifères fossiles de St. Gerand le Puy.

Article XII. — ON THE SKULL OF BUNÆLURUS, A MUSTELINE FROM THE WHITE RIVER OLIGOCENE.

By W. D. Matthew.

Bunælurus was described by Prof. Cope in 1873[1] from fragments of the lower jaw, which until now have remained the only representation of the genus. Cope referred it to a position in the Mustelidæ near *Putorius* and *Plesiogale;* Dr. Schlosser in his later revision of the European carnivora[2] considered it close to or identical with *Palæogale* (in which he includes part of *Plesiogale*). Dr. Wortman has recently suggested[3] that it might not improbably prove to be a direct descendant of certain of the Viverravidæ.

A finely preserved skull found by Mr. Thomson of the American Museum Expedition of 1901, in the Upper Oreodon

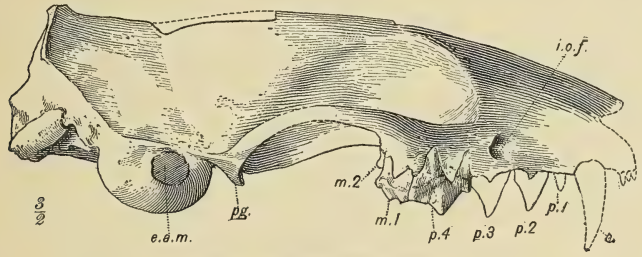


Fig. 1. Side View of Skull.

beds of East Pawnee Butte, Northeastern Colorado, is the subject of the present description. No lower jaw is with it, so that it cannot be positively identified. But the close correspondence in point of size with *B. lagophagus*, the type of which is from the same horizon and region, and the correspondence of the teeth of our skull with the upper teeth of the more carnassial section of the Mustelinæ and of the teeth of *Bunælurus* with the lower teeth of the same group,

[1] Synopsis New Vert. Col., p. 8; Ann. Rep. Hayd. Sur., 1873 (1874), 507; Tert. Vert., p. 946, pl. lxvii a, figs. 13, 14.
[2] Affen Lemuren, u. s. w. d. Europ. Tertiärs, p. 386.
[3] Amer. Jour. Science, 1901, Vol. XII, p. 145, footnote.

make the identification reasonably safe. No other Musteline is known from the White River.

The characters of the skull confirm the views expressed by Cope and Schlosser as to the position of the genus. It is *Palæogale* with a minute second molar still retained. It belongs to the primitive division of the Mustelinæ, with triangular first molar, no posterior flange on the protocone. The carnassial is primitive in character, somewhat resembling that of *Cynodictis gregarius*, the protocone very large, the shear more oblique than in modern Mustelinæ, less so than in *Cynodictis*, the fissure between protocone and postero-external blade still quite well marked. There is a small antero-internal basal cusp and a less marked antero-external one. The second and third premolars are of moderate size without trittocones, much higher than in *Mustela*, higher and proportionately larger than in *Putorius*. The first premolar is a single-rooted tooth of small size; first and second premolars are spaced. Alveoli of canines, of moderate size, are preserved.

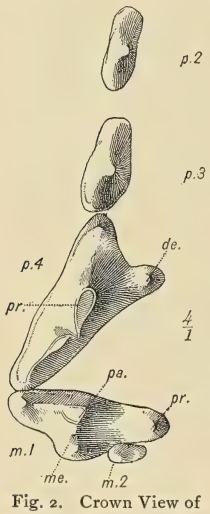


Fig. 2. Crown View of Teeth.

The bullæ are of primitive character, inflated, short and prominent, instead of flattened and elongated as in *Mustela* and *Putorius*. The palate extends backward only to opposite the anterior edge of the first molar, while in modern Mustelines it extends considerably behind the teeth. The shorter bullæ leave a much larger surface of the sphenoids and occipitals exposed; the short stout paroccipital process is entirely free of the bulla. The occipital and sagittal crests have the same outlines as in *Putorius ermineus*, but the posterior lobes of the brain are separated from the cerebral lobes by a strongly marked depression; the arches are much heavier, muzzle much longer, resembling that of *Mustela* more nearly, but flatter, longer, more slender toward the tip; infraorbital foramen smaller, postorbital process of the frontal less prominent.

Postorbital constriction much more narrow than in *M. americana*, somewhat more than in *P. ermineus*. Size slightly greater than the weasel.

Bunœlurus is one of the primitive group of Mustelinæ found chiefly in the Oligocene of Europe. It belongs to the Putoriine section, which more nearly approaches the Felidæ (through *Proailurus*) in dental reduction (the typical Musteline section more nearly approaching *Cynodictis* and the Viverridæ), but shows little indication of the shortening of the face characteristic of modern *Putorius*.

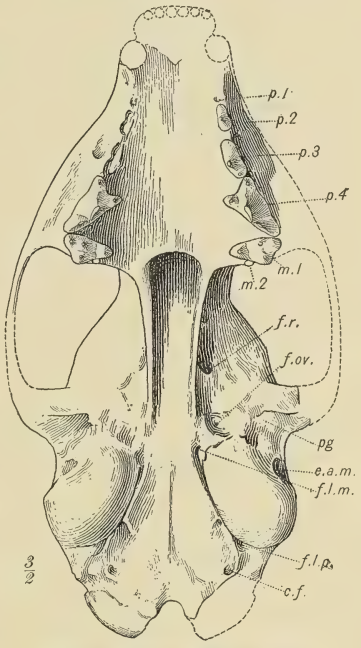


Fig. 3. Inferior View of Skull.

Following are the more important primitive characters:

1. Dentition less reduced, four premolars and two molars in upper jaw.
2. Fourth premolar more triangular, shear more transverse, notch behind protocone deeper.
3. First molar more viverrine in shape, protocone not expanded transversely, para- and metacones more distinct.
4. Second molar present although minute.
5. Posterior nares not roofed over behind m^1.
6. Bullæ short, round, and prominent, instead of long and flattened.
7. Paroccipital process free.
8. Cerebrum small and not extending over cerebellum, transverse sulcus strongly marked on external surface of skull by a wide depression.
9. Postorbital processes very rudimentary, postorbital constriction narrow.
10. Infraorbital foramen small.

The skull is identified with *Bunœlurus* upon the following evidence: *Bunœlurus* appears to belong to the more carnas-

sial section of the Mustelinæ, typified among modern genera by *Putorius*, among ancient ones by *Palæogale*, rather than to the section with more tubercular teeth, typified among modern genera by *Mustela*, among ancient ones by *Plesictis*, *Stenoplesictis*, etc. The latter group retains the metaconid on m , and correspondingly the paraconule on m^1. The former group has no metaconid on the lower carnassial, and on the upper tubercular there is no trace of conules, and the protocone is smaller in proportion. The primitive members of this Putoriine group are hardly distinguishable from primitive felines; *Proailurus*, considered by most writers as a Felid, is placed by Dr. Schlosser (advisedly as it seems to the present writer) among the Mustelids of this group. *Bunælurus* presumably belongs to the primitive division of the Putoriine group.

The White River skull under discussion belongs unquestionably to the Putoriine group, and with the primitive members thereof. It has the strongly transverse tubercular, with reduced protocone and no paraconule. The upper teeth correspond in size and in proportions with the lower teeth on which *Bunælurus* is based. These were found in the same formation and horizon as the skull, at a locality about fifty miles further to the eastward.

Article XIII.—A NEW BEAR FROM THE ALASKA PENINSULA.

By J. A. Allen.

Plates XXX and XXXI.

Another [1] interesting and unexpected addition to the mammalian fauna of the Alaska Peninsula, obtained by the Andrew J. Stone Expedition, is a new species of large bear, represented by a skin and skull obtained by Mr. Stone at Portage Bay, opposite Port Müller, Alaska Peninsula.

This bear is of special interest not only on account of its large size, but also on account of the cranial differences it presents in comparison with the bears of the Kenai Peninsula and Kadiak Island. The skull and skin belong to different individuals, the skin being that of (probably) a very old male, and the skull that of a full-grown but not aged adult. In recognition of Dr. C. Hart Merriam's excellent revision of the North American Bears [2] this species may appropriately bear the name

Ursus merriami, sp. nov.

Type.—No. 17622, skull ♂ ? adult, but not old, Portage Bay, opposite Port Müller, Alaska Peninsula, 1901; Andrew J. Stone Expedition.

Topotype.—No. 17621, skin, ♂ ? adult, Portage Bay, Alaska, May, 1901; Andrew J. Stone Expedition.

Head yellowish brown, with a broad dark brown median band running forward from the nape as far as the eyes; cheeks and throat dull dark brown with a cast of reddish; whole dorsal region dark brown with the tips of the hairs light, resulting in a yellowish gray surface tint, which is lightest over the shoulders and darker posteriorly and on the sides; lower part of flanks, whole ventral surface, and the limbs dark ruddy brown, much darker than the upper surface of the body.

Measurements.—The external measurements available are only such as can be obtained from the flat skin, as follows: length from nose to tail, 3050 mm.; from tip to tip of outstretched fore limbs, 3230; from

[1] See this Bulletin, Vol. XVI, Art. X, pp. 119–127, March, 1902.

[2] 'Preliminary Synopsis of the American Bears.' Proc. Biol. Soc. Washington, Vol. X, pp. 65–83, pll. iv–vi, April 13, 1896.

tip to tip of outstretched hind limbs, 2645. Longest fore claw, from base to tip in a straight line, 70; chord of arc, lower surface of claw, 57; transverse diameter at base, 14; antero-posterior diameter at base, 27. Longest hind claw, 33; transverse diameter at base, 10; antero-posterior diameter at base, 21. The claws are much longer, less curved, and much stouter than in the Alaskan Grizzly.

Skull.—Long and narrow, with moderately expanded zygomatic arches, and comparatively low and not greatly expanded forehead. In fact, the skull, seen only from above, might almost be referred to the Polar Bear group. It consequently follows that it is in strong contrast as regards its general contour with the broad, relatively short, high skull of *Ursus middendorffi* and allied forms.

Greatest length (front of premaxillary to end of occipital crest), 395 mm.; basal length (inner base of incisors to posterior border of condyles), 380; occipito-sphenoid length, 100; postpalatal length, 150; zygomatic breadth, 209; interorbital breadth, 81; breadth at post-orbital processes, 110; length of nasals, 108; palatal length, 186; palatal breadth, 51; occipito-nasal length, 330; length of upper molar-premolar series, 114; length of lower jaw, 260; height of coronoid, 114; length of lower molar-premolar series, 132.

Ursus merriami seems most nearly allied to *U. dalli* Merriam, from Yakutat Bay, the skull being long and narrow with the interorbital region only slightly elevated and not greatly expanded, in this respect differing greatly from *U. middendorffi* of Kadiak Island and the eastern portion of the Alaska Peninsula. The palatal region, however, is longer and one fifth narrower than in *U. dalli*,[1] from which it differs so much, and in so many important details that further comparison of the two forms is necessary.

Since preparing the foregoing paper and the illustrations accompanying it, I have received a paper from Dr. Merriam entitled 'Two New Bears from the Alaska Peninsula,'[2] in which he describes a bear from Pavlof Bay under the name *Ursus dalli gyas*. This is probably the nearest ally of *Ursus merriami* yet described, but the description of the skull is brief and incomplete, and does not, in several important points,

[1] For comparison in the present connection Dr. Merriam has kindly loaned me a skull of *Ursus dalli* (No. 75047, from "near Mt. St. Elias"), figured in pl. vi, fig. 5, of his paper already cited—a very old specimen with much worn teeth.

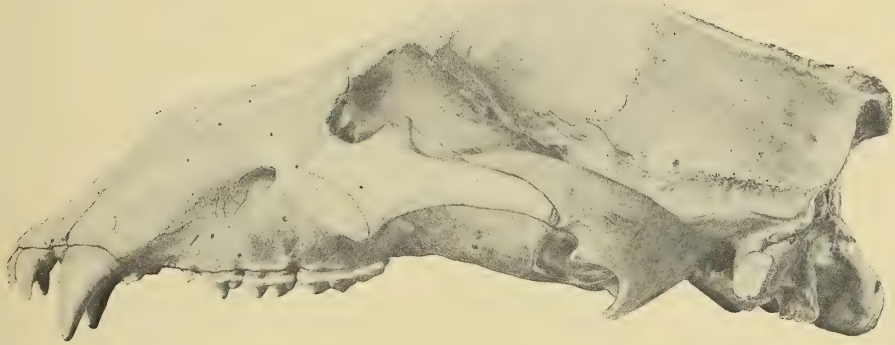
[2] Proc. Biol. Soc. Washington, Vol. XV, pp. 77–79, March 22, 1902.

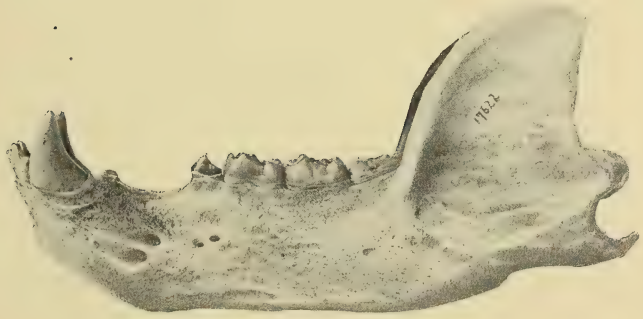
agree well with the skull of *U. merriami*. It seems to indicate a wholly different type of animal, especially in having the skull "much larger, heavier and more massive" than in *U. dalli*, with the cranium higher and more vaulted, features just the opposite of those presented by *U. merriami*. Neither does the brief description of the teeth accord well with the dentition of *U. merriami*. (See Plates xxx and xxxi.)

The locality of Mr. Stone's specimens is Portage Bay, on the Alaska Peninsula, opposite the Shumagin Islands, some 600 to 700 miles west of the type locality of *Ursus dalli gyas*, and in a very different faunal area.

Ursus merriami, sp. nov.

½ nat. size.





URSUS MERRIAMI, SP. NOV.

Skull and lower jaw $\frac{1}{3}$ nat. size teeth (lower molar series) slightly less than nat. size.

Article XIV.—A NEW SHEEP FROM THE KENAI PENINSULA.

By J. A. Allen.

Through the various expeditions of Mr. Andrew J. Stone the Museum is in possession of fine series of the forms of *Ovis* found in northern North America, including the dark form known as *Ovis stonei* and the light form or White Sheep known as *Ovis dalli*.

In 1897 Mr. Stone collected a large series of the latter from the main Rocky Mountains in latitude 66° 30′, which, while not topotypes, doubtless very nearly represent the typical phase of *O. dalli*. During the season of 1901 he also obtained a large series of White Sheep from the Kenai Peninsula. As both series are in summer coat, they are strictly comparable. *Ovis dalli* in summer coat is yellowish white, with the extreme tips of the hairs cinnamon brown, which impart a decided yellowish brown shade to the greater part of the dorsal surface of the animal. In the series from the Kenai Peninsula the general tone of the color throughout is dingy grayish white instead of yellowish white, with the tips of the hair grayish instead of cinnamon. These color differences are probably adventitious, due to earth stains, and therefore not diagnostic. The skull, however, varies in the two forms, so that the Kenai animal is clearly entitled to subspecific separation, and may be called

Ovis dalli kenaiensis, subsp. nov.

Type, No. 17609, ♂ adult, head of Sheep Creek, Kenai Peninsula, July 10, 1901; Andrew J. Stone Expedition.

Similar in coloration (except from adventitious staining from the soil) and external measurements to true *Ovis dalli* (specimens from Nahanna Mountains and main Rocky Mountains, lat. 66°), but presenting important cranial differences. Adult male skulls of the two forms have practically the same dimensions and the same proportions, except that the posterior nares in *O. dalli kenaiensis* are uniformly shorter than in *O. dalli*, the length in four old males in the former being 59 mm. (58–60), and in three old males of the latter 67 mm. (65–68), showing a marked shortening of the post-palatal region in *O. d. kenaiensis*. This is further indicated by the distance between the base of the paroc-

cipital process and m^3, which in *kenaiensis* is 84 mm. and in *dalli* 94 mm., while the basal length of the skull is the same in both forms. Correlated with this is a marked difference in the angle made by the basioccipital axis with the palatal axis. These differences are strongly pronounced, as shown in the accompanying illustrations (Figs. 1 and 2). The teeth are also broader and heavier in the Kenai form, the tooth-row is more convex outwardly, and the palate is broader.

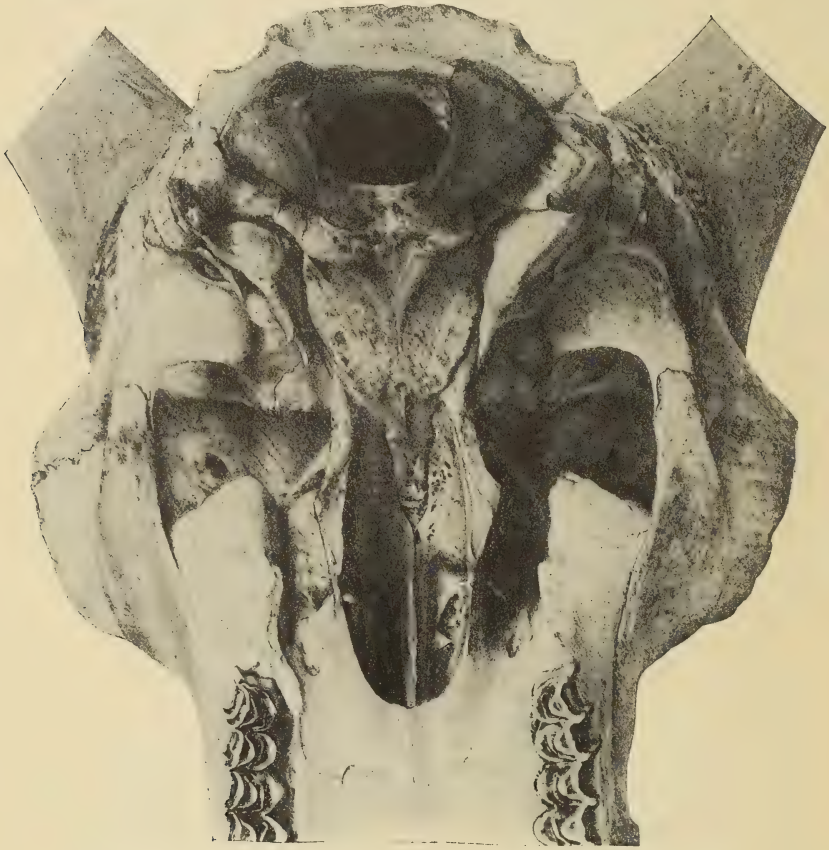


Fig. 1.—*Ovis dalli kenaiensis*, ♂ ad., No. 17609, Kenai Peninsula. $\frac{2}{3}$ nat. size.

Considering the great distance separating these two forms of the White Sheep, it is perhaps surprising that the external differences are not more marked. The fact that they are

normally snow white at all seasons, aside from accidental staining, leaves, however, little opportunity for very marked differences in external features. While examples from widely distant localities, taken in summer pelage, may on compari-

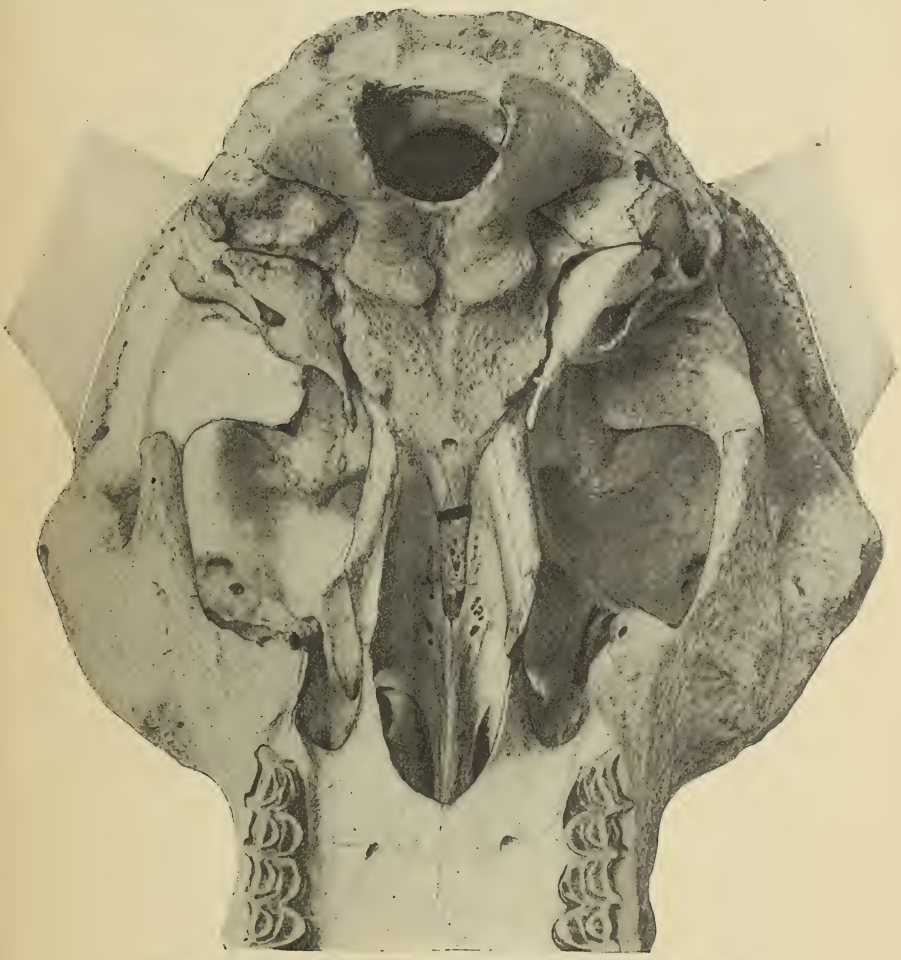


Fig. 2.—*Ovis dalli*, ♂ ad., No. 16223, Rocky Mts., Lat. 66° 30′. ⅔ nat. size.

son present marked differences in coloration, Mr. William T. Hornaday has very conclusively shown[1] that such differences

[1] Fifth Annual Report of the New York Zoölogical Society, June, 1901, pp. 81–91.

are deceptive, on casual examination, and not real. He says :

"A very convincing explanation of the condition of some skins of White Mountain Sheep, which might be described as 'dirty white,' is found in the following interesting statement furnished me on this point by Professor Lewis Lindsay Dyche, of the University of Kansas, based on extensive personal observations in the Alaskan Mountains :

"'The White Mountain Sheep are a "dingy or dirty-white" during the summer season only. This is particularly true during the months of July and August. By the first of July the animals have shed their long, thick coats of winter hair. At this time they are almost naked, so to speak, the hair being not more than from $\frac{1}{4}$ to $\frac{1}{2}$ inch in length. The animals frequent the sunny sides of the mountain ranges, and make their beds in masses of shale rock, or on slopes where there is more or less dirt. They frequently paw the rocks and earth away so as to make a form large enough to sleep in. These places become more or less covered with droppings. Light snows and rains come, the earth is damp, and the animals get their hair stained until they become a "dingy or dirty-white." By the first of September the snows are falling, and the animals have a fair coat of hair. They make their beds in the snow, and gradually become white. I saw skins that were white. The ones I got early in September were nearly white, but not beautiful and snow-white like those taken late in the fall and early winter. Pure white skins in the hands of the Indians soon become soiled, and dingy with smoke.'"

Article XV.—DESCRIPTION OF A NEW CARIBOU FROM NORTHERN BRITISH COLUMBIA, AND REMARKS ON *RANGIFER MONTANUS*.

By J. A. Allen.

A series of Caribou collected by Mr. Andrew J. Stone for the American Museum in the Cassiar Mountains, northern British Columbia, September 15–26, 1897, were provisionally referred by me to *Rangifer montanus*,[1] described in August, 1899, by Mr. Ernest Seton-Thompson [2] from a mounted specimen in the Museum of the Canadian Geological Survey, "taken in the Illecillewaet watershed, near Revelstoke, Selkirk Range, B. C., in 1889." A series of four specimens, two fine adult males and two fine adult females, taken September 26, 1901, have just been received by the Museum, collected in the Gold Range Mountains, twenty-five miles southeast of Sicamous, and are thus practically topotypes of *Rangifer montanus*. These specimens show that the Caribou from the Cassiar Mountains is very different from *Rangifer montanus* of the Selkirks. The specimens of the two series having both been taken during the last half of September, they are strictly comparable as regards season.

Rangifer osborni, sp. nov.

Rangifer montanus Allen, Bull. Am. Mus. Nat. Hist., XIII, 1900, Art. I., pp. 1–18, figs. 2–6, 11, 15, and 16. Not *Rangifer montanus* Seton-Thompson.

Type, No. 15714, ♂ ad., Cassiar Mountains, British Columbia, Sept., 1897; Andrew J. Stone (James M. Constable Expedition).

The largest of all known Caribou, with very long and very heavy antlers, which have a low and very long backward sweep.

Adult Male, in September.[3]—General color above clove-brown, darkest on the head, back, thighs, and lower edge of the sides of the chest, and still darker, blackish brown, on the breast and limbs; muzzle, including the whole end of the nose and front border of the lower lip,

[1] This Bulletin, Vol. XIII, 1900, pp. 1–18, April 3, 1900.
[2] 'Preliminary Description of a New Caribou,' The Ottawa Naturalist, XIII, August, 1899, pp. 129, 130.
[3] The following description and measurements are from my former paper (*l. c.*, pp. 5 and 6).

silvery grayish white, succeeded by a broad band of blackish brown, which fades posteriorly on the sides of the head and below into the general color, but extends broadly over the front part of the head to

Fig. 1. *Rangifer osborni*, ♂ ad., No. 15714, Cassiar Mts., B. C.; A. J. Stone. $\frac{1}{3}$ nat. size.

the eyes; neck all round brownish gray, lighter on the sides than above, becoming nearly white in front; the gray color of the sides of the neck extends posteriorly over the anterior part of the shoulders, and is continued as an ill-defined broad band on the sides of the chest; ventral surface, from the chest posteriorly, grayish white, passing into pure white posteriorly and on the inside of the thighs; rump patch white, large and sharply defined; tail above centrally dark brown like the back, broadly edged and tipped with white; a narrow band of pure white borders the hoofs; ears externally dark brown, mixed with gray and edged with blackish; internally much lighter, becoming light gray at the inner base. In one specimen there is a broad band of whitish

Fig. 2. *Rangifer osborni*, ♂ ad., Cassiar Mts., B. C.; Coll. A. J. Stone. $\frac{1}{5}$ nat. size.

gray above and below the eye, forming an imperfect eyering; but this seems exceptional, and is probably a remnant of the summer coat, the majority of the specimens having the eye region dark like the adjoining parts of the face.

Female and Young-of-the-year.—The female does not appear to differ materially from the male. The young-of-the-year, however, is much lighter than the adult, having the whole ventral area white, and the whole neck and the sides much lighter; the dark color of the upper parts is lighter and restricted in area to the middle of the back from the shoulders posteriorly; the tail is all white except at the base above.

Measurements.—The following are the collector's measurements taken from the freshly killed specimens before skinning:

External Measurements.

	No. 4[1] ♂ ad.	No. 5 ♂ ad.	No. 6 ♂ ad.	No. 7 ♂ ad.	No 8. ♀ ad.	No. 9 ♀ juv.
Total length	2083	2057	2210	2172	1930	1499
Tail	152.4	152.4	152.4	152.4	177.8	114.3
Height at shoulder	1321	1270	1346	1397	1245	991
Hind limb to hip	1295	1334	1245	1359	1145	965
Length of hind foot	610	635	635	597	597	522
Fore leg to elbow	597	584	610	646	521	432
Width of chest	326	326	368	368	305	229
Depth of chest	775	787	787	749	711	610
Ear[2] from crown	....	....	140	140	....	....
" " notch	....	....	115	120	....	....

Skull.—In addition to its large size, the skull of *R. montanus* is peculiar in the unusual elongation of its facial portion. The antlers are similar in length and proportions to those of the Barren Ground Caribou, but more massive, with the palmated portions much broader and heavier. (For measurements see p. 153.)

Of the six specimens collected by Mr. Stone in the Cassiar Mountains, four are adult males, one is an adult female, and the other a young-fo-the-year female. The female and three of the males agree very closely in coloration; the other male, apparently the oldest of the series, is much paler-colored throughout.

[1] Collector's numbers. No. 6 = Mus. No. 15714; No. 8 = Mus. No. 15715; No. 9 = Mus. No. 15716. The original measurements, given in inches, are here reduced to millimetres.

[2] Measurements from dry skins, exclusive of hair.

COMPARATIVE MEASUREMENTS OF SKULLS OF *Rangifer osborni* AND *R. montanus*.

	R. osborni.		*R. montanus.*			
	15714 ♂ ad.	15715 ♀ ad.	17971 ♂ ad.	17972 ♂ ad.	17974 ♀ ad.	17973 ♀ ad.
Basal length	420	360	430	420	360	355
Tip of premaxilla to tip of nasals	125	100	121	120	97	101
Tip of premaxilla to alveolus of first premolar.	148	126	142	137	115	115
Length of nasals	123	122	142	122	129	107
Greatest orbital breadth	182	156	180	172	160	155
Breadth (above m^2)	127	113	122	120	102	108
Zygomatic breadth	148	136	148	157	134	131
Mastoid breadth	149	116	146	147	120	113
Palatal breadth at m	73	62	72	61	60	55
Depth of skull between antlers	112	86	101	94	88	81
Length of upper toothrow (crown surface)	99	97	100	101	96	93
Diastema (canine to pm^1)	72	59	72	71	65	62
Distance between antlers just below burr	78	53	64	75	68	75
Distance between outer edge of antlers just below burr	135	95	139	137	116	102
Length of mandible, incisive border to angle	330	280	310	310	270	275
Angle to condyle	109	102	115	105	95	87
" " tip of coronoid	148	137	155	144	127	127
Depth of mandible at m_2	38	31	40	39	34	31
Length of lower toothrow	103	103	105	110	99	101
Diastema	130	108	121	115	99	101
Antlers, length of main beam	1235	405	810	745	370	290
" distance apart at point of palmation	875	146	470	320	190	150
" distance between tips	790	—	393	450	—	—
" distance between points at tip of main beam	415	100	360	270	235	300

This form of Caribou differs markedly in color from the Woodland Caribou in being very much darker throughout, in

its larger size, longer and heavier antlers, and in the large size of the white rump patch. This patch, measured across the base of the tail, has a breadth of 250 mm., but is divided through the middle by the dark band, 50 mm. wide, that

Fig. 3. *Rangifer montanus*, ♂ ad., No. 17971, Gold Range Mountains, B. C. ½ nat. size.

passes down the tail, the white patch being thus separated into two areas, each with a transverse width of 100 mm.

The relationship of *R. osborni* to *R. montanus* is considered below.

In this connection it is due Mr. Madison Grant to state that

about a year ago he expressed his conviction to me that the Caribou from the Cassiar Mountains, referred provisionally

Fig. 4. *Rangifer montanus.* Same specimen as Fig. 3. $\frac{1}{7}$ nat. size.

to *R. montanus*, would prove to be different from true *R. montanus* of the Selkirk Range, and it is through his instigation and valued assistance that the four Selkirk specimens

described below have been obtained for the Museum. They were procured through Mr. T. E. Wilson of Banff Hot Springs, Alberta.

The Cassiar form is named for my colleague, Prof. Henry F. Osborn, Curator of the Department of Vertebrate Palæontology, in recognition of his cordial assistance in obtaining funds to equip and maintain the Andrew J. Stone Expeditions.

Rangifer montanus *Seton-Thompson.*

Rangifer montanus SETON-THOMPSON, Ottawa Naturalist, XIII, No. 5, Aug., 1899, 129. Type locality, Selkirk Range, near Revelstoke, B. C. Type, mounted specimen, Museum Canadian Geological Survey, Ottawa, Canada.

Mr. Seton described the type of *Rangifer montanus* as follows:

"The general colour is a deep umber brown, very glossy, and darkening nearly to black on the lower parts of the legs. The neck is dull greyish white, also the underside, the buttocks, lips and belly. Along the ribs on each side is a greyish patch a little lighter than the surrounding brown. The white fringe above each hoof is shining white and *very narrow*."

Fig. 5. *Rangifer montanus*, ♀ ad., No. 17973, Gold Range Mountains, B. C. About ⅛ nat. size.

The date of capture is given as 1889, the month or season not being stated. The specimens now described were killed the last week in September, and are apparently very much

darker in color than Mr. Seton's description would imply. They may be described as follows:

Whole body and legs blackish brown, varying (in different specimens) to glossy black over the middle of the dorsal area from shoulders to rump; lighter, more brownish black, on the flanks and ventral sur-

Fig. 6. *Rangifer montanus*, ♀ ad. Same specimen as Fig. 5. About $\frac{1}{8}$ nat. size.

face; inguinal region, sides and under surface of tail, a narrow band bordering the hoofs, and ventral median line of neck, grayish white; nose and edge of lips grayish white; sides of neck grayish brown; top of neck and shoulders darker grayish brown varied with blackish and, in the males, tinged more or less with rusty. The females are much

darker than the males, especially on the neck and shoulders, but have the grayish white areas of the males replaced by nearly pure white.

Rangifer montanus, in late September pelage, may be described in general terms as a *black* Caribou, with the neck and shoulders, especially in the males, much lighter than the body and limbs; while *R. osborni*, in corresponding pelage, is a *brown* Caribou, with much more white on the rump and posterior ventral surface, and the whole neck and shoulders, as well as the back and limbs, much lighter than in *R. montanus*.

The specimens of *R. montanus* are without measurements, but the species is apparently about the same size as *R. osborni*, as shown by the measurements of the skull given above.

In addition to the marked contrast in color, there are striking differences in the size and form of the antlers in the two forms, the antlers of *R. montanus* being of the typical Woodland Caribou type, and in their relative shortness and much branched character recall strongly the antlers of *R. terræ-novæ*, but they are much lighter and more slender than in that species. They have the same abrupt upward curvature of the main beam, in contrast with the much longer and heavier and more depressed backward-sweeping main beam seen in *R. osborni*.

The nearest known relative of *R. osborni* is *R. stonei* from the Kenai Peninsula, which, however, is a differently colored animal, with the rostral portion of the skull much shorter and broader, and other important cranial differences. The antlers also differ greatly in the two species, the antlers of *R. stonei* more resembling those of the Barren Ground and Greenland species.

Article XVI.— NOMENCLATORIAL NOTES ON AMERICAN MAMMALS.

By J. A. Allen.

I.— The Generic Names *Alce* and *Alces*.

Alce and *Alces* are variants of the same word, as used by various authors, for the group of Deer of which *Cervus alces* Linn. is the type, and also in a specific sense for Linnæus's *Cervus alces*. Both forms of the word have been used indifferently, or according to preference,— in some cases both forms by the same author,— for the same animal, from Pliny down to the systematists of the seventeenth and eighteenth centuries.

The form *Alce* was first introduced into technical nomenclature in a generic sense by Blumenbach in 1803 (Manuel d'Histoire Naturelle, II, p. 407) for the extinct Irish Elk, which he named *Alce gigantea*, this being its first technical name. *Alce* thus antedates *Megaceros* Owen (1844).

In 1827 Hamilton Smith (Griffith's An. King., V, p. 303) used the same form of the word in a subgeneric sense for the *Cervus alces* group; and *Alce* has since been used in the same way by various later writers, as Wagner, 1844, 1855, Baird, 1857, Allen, 1869, Gilpin, 1871, Merriam, 1884, Miller, 1897, etc.

The form *Alces* appears to have been first used for the same group by Jardine in 1835 (Nat. Libr., Mamm., III, 1835, p. 125) and again by Ogilby in 1836 (P. Z. S., 1836, p. 135), and by numerous subsequent writers. It has, however, been often incorrectly attributed to Hamilton Smith (1827) instead of to Jardine (1835) (*cf.* Blasius, Säug. Deutschl., 1857, p. 434; Trouessart, Cat. Mamm., 1897, p. 886; Elliot, Synop. N. Am. Mamm., 1901, p. 37). The two forms having been treated as the same word, *Alces* has been given preference apparently on the supposed ground of correctness, since it was the form used by Linnæus for the species.

In short, from time immemorial, as well as in modern

nomenclature, *Alce* and *Alces* have been treated as the same word, referring (except in the case of Blumenbach) always to the same thing. Mr. Lydekker, in view of these facts, has taken *Cervalces* Scott (1885) as the first available name for the Alcine group of deer. It is clear, however, as shown by Scott (Proc. Acad. Nat. Sci. Phila., 1885, pp. 181–202, figs. 1–7 and pl. ii), that *Cervalces* is generically distinct from *Alces*, and there being no other name available, I propose **Paralces** for the latter group, with *Cervus alces* Linn. as the type. The present known forms are:

1. *Paralces alces* (Linn.).
2. *Paralces americanus* (Clinton).[1]
3. *Paralces gigas* (Miller).

This case has an interesting bearing upon the question as to whether or not words etymologically the same but differing by a single letter are both available in nomenclature. As the affirmative side of this question is supported, with or without some reservation, by a number of prominent zoölogists, it is interesting to see how the principle would work in a case like *Alce* and *Alces*. There are four well defined groups of deer characterized by having palmated antlers, but which differ so much in other structural features as to fairly entitle them to generic (certainly to subgeneric) rank. Two of these — *Alce* Blumenbach and *Cervalces* Scott — are extinct; the other two — *Alces* Ham. Smith and *Dama* Ham. Smith — relate respectively to the so-called Moose and Fallow Deer groups. All are closely related types of a single subfamily. As *Alce* and *Alces* have been used interchangeably by the majority of writers for more than half a century, can they now be used as designations for closely allied genera without involving uncertainty? As this is not an isolated case, but the type of a numerous class, it seems to me that the adoption of the principle that the difference of a single letter in the spelling of names etymologically the same renders several forms of the same word tenable in nomenclature would often prove inconvenient and confusing. In the present case we would have,

[1] Concerning the authority for the name *americanus* see Osgood, Proc. Biol. Soc. Wash., XV, 87, April 25, 1902.

for example, *Alce* as the proper generic designation of a fossil elk, and *Alces* for an allied group of living forms, for which latter both *Alce* and *Alces* have been in more or less general use for more than half a century, according to the predilections of different writers.

II.—Some Other Names of American Deer.

Mr. Osgood (Proc. Biol. Soc. Wash., XV, p. 87, April, 1902) has recently called attention to the fact that the authority for the specific name of *Paralces americanus* should be DeWitt Clinton, 1822, instead of Jardine, 1835. In this connection he says he does not admit that the alleged name "[*Cervus dama*] *americana* Erxleben" is recognizable, and that therefore *Cervus americanus* Clinton is available for the Moose, a conclusion that seems beyond question. The specific name *virginianus* (*Dama virginiana*, as I prefer to call it) is thus the proper name of the Common or Virginia Deer.

I cannot, however, quite agree with Mr. Osgood (*l. c.*) that *Cervus mexicanus* Lichtenstein is available, as he contends, for a Mexican deer, since it is preoccupied by a *Cervus mexicanus* of Zimmermann, Gmelin, and other early authors, which is wholly unidentifiable, except in so far as it was based on some malformed antlers from an unknown locality figured and described by Pennant (see *antea*, p. 16). These Mr. Osgood thinks must have been the antlers "of some form of American white-tailed deer."

The case of *Dama* vs. *Odocoileus* (see *antea*, pp. 18–20) has already received some attention from authors, its use being opposed by some, held in abeyance by others (Bangs, Proc. Boston Soc. Nat. Hist., XXXIX, p. 21, April, 1902), and deemed admissible by one (Thomas, Novit. Zool., IX, 136, April, 1902). The fact that its adoption in this sense will prove 'inconvenient,' because used more or less currently for the Fallow Deer of Europe (*cf.* Sclater, Ann. and Mag. Nat. Hist. (7) IX, April, 1902, p. 289), is hardly to be considered. It has, however, been urged against it (Miller, Proc. Biol. Soc. Wash., XV, p. 39, March, 1902) that it stands on the same basis as various other names used by Zimmermann.

Mr. Miller cites as an example, "3. *Hyena*," under *Canis*, but omits to note that the generic name *Hyæna* of authors, as also the species *Hyæna striata*, dates from this same work of Zimmermann's (*cf.* Trouessart, Cat. Mamm., pp. 317 and 319; W. L. Sclater, Mamm. S. Afr., I, 1900, 83, etc.).[1] *Vulpes* is a case parallel to that of *Hyæna*,[2] but *Vulpes* Zimmermann = *Vulpes* Brisson. *Jerboa* would be tenable except that, in uncertainty as to date between Zimmermann and Erxleben, it seems best to retain its exact equivalent *Jaculus* of Erxleben. In other cases the examples cited by Mr. Miller are not to be considered as parallel to the case of *Dama*.

III. — The Generic and Specific Names of the Peccaries.

In 1897, Dr. T. S. Palmer called attention (Proc. Biol. Soc. Washington, XI, p. 174) to the priority of the name *Tayassu* of Fischer (1814) for the Peccaries, this name antedating *Dicotyles* G. Cuvier (1817) by three years. As Dr. Palmer says, Fischer recognized two species in due form under the names *Tayassu pecari* and *T. patira*, of which Fischer gave brief diagnoses. His diagnosis of *T. pecari* shows that the species was the White-lipped Peccary, *Sus albirostris* Illiger, 1815, although he cited "*Sus tajassu* Lin. Gmel. Syst. nat. III, n. 6,"[3] which is not, however, *Sus tajassu* Linn. 1758. His second species, *T. patira*, is the Collared Peccary, *Sus patira* Sonnini (Nouv. Dict. d'Hist. Nat., XVII, 1803, p. 156 = *Sus tajassu* Linn. 1758); thus both species of Peccary at that time known were included in his genus *Tayassu* and identifiably diagnosed.

In 1817 Fischer had reached the conclusion that 'bar-

[1] *Hyæna* Zimmermann, Spec. Zool. Geogr. 1777, 365, 470.
Hyæna striata Zimmermann, Spec. Zool. Geogr. 1777, 366 = *Canis hyæna* Linn. Syst. Nat. 1758, 40.
Hyæna maculata Zimmermann, Spec. Zool. Geogr. 1777, 470 = *Canis crocuta* Erxleben, Syst. Reg. An. 1777, 578.

[2] *Vulpes* Zimmermann, Spec. Zool. Geogr. 1777, 175, 470. At page 470 three 'species,' or different kinds, are enumerated under *Vulpes*.

[3] This reference is erroneous, occurring in neither the 10th nor 12th editions of Linnæus, nor in Gmelin. In other cases "Lin. Gmel." is found to refer to Gmelin and not to Linnæus. Gmelin's *Sus tajassu* is composite, and the characters he gives and most of his citations apply about equally to both species. Hence the reference "*Sus tajassu* Lin. Gmel." does not fix a type. Azara (1801) was the first naturalist, as said by Sonnini, to distinguish and describe the two animals. Sonnini also had personal experience with both in the interior of Guiana, and in 1803 confirmed Azara's discrimination of the two forms. Sonnini also comments at length on the errors of previous authors. See the words "Patira (*Sus patira*)," and "Pecari (*Sus tajassu* Linn.)," in Nouv. Dict. d' Hist. Nat., XVII, 1803, pp. 156, 157, and 180–185.

barous' names should not be retained in zoölogical nomenclature and accordingly changed several of his own names, as well as those of other authors, to conform to what he considered a correct principle of nomenclature. Among the names thus changed is his *Tayassu*, for which he substituted *Notophorus* (Mém. Soc. Imp. des Nat. Moscou, V, 1817, p. 418), considering as the equivalents of this name "*Les Pecaris*, *Dicotyles*, Cuv. Règne an. p. 237." Thus *Notophorus* is not only a pure synonym of *Dicotyles*, but was intended simply as a substitute for *Tajassu*, of which it is a pure synonym. The only species mentioned in this connection is "*Sus tajassu* Lin. Gmel.," but this can hardly be considered as limiting *Notophorus* to this species, it being given merely as an illustration of the group, as in the majority of the hundred or more other genera recognized in this memoir. Besides, "*Sus tajassu* Lin. Gmel." is unidentifiable, as shown above (see last footnote, p. 162); if *Sus tajassu* Gmel. was intended, the case is not helped, as Gmelin's *Sus tajassu* is composite and stands for all the Peccaries then known.

Hence it was not permissible for Gray in 1868 (P. Z. S., 1868, p. 43) to adopt for his two genera of Peccaries the names *Dicotyles* and *Notophorus*, although Dr. Gill (Proc. Biol. Soc. Washington, XV, p. 38, March 5, 1902) claims that he "was justified by general usage in restricting the name [*Dicotyles*] as he did, although he would have done better to have given a new name to the genus he called *Dicotyles* and [to have] retained the latter name for the one designated *Notophorus*." This, however, is contrary to the principle "once a synonym [homonym] always a synonym." Dr. Merriam was thus quite justified in considering both *Dicotyles* and *Notophorus* as synonyms of *Tayassu*, and in proposing a new name, *Olidosus* (Proc. Biol. Soc. Washington, XIV, 1901, p. 119), for the group of White-lipped Peccaries.

It is further evident that the earliest specific name of the White-lipped Peccary is *pecari* G. Fischer, 1814.

In establishing the genus *Tayassu* Fischer referred to it two species, as follows: (1) *Tayassu pecari:* "T. corpore nigro, maxilla inferiori alba;" and (2) *Tayassu patira:* "T. corpore

nigro, fascia humerali alba" (= *Sus patira* Sonnini, 1803 = *Sus tajacu* Linn., 1758). *Tayassu pecari* G. Fischer, 1814, antedates *Sus albirostris* Illiger, 1815, by one year, and *Dicotyles labiatus* Cuvier, 1817, by three years, for the same animal, namely, the Tagnicati of Azara (Quad. Parag., I, 1801, p. 25), of which the type locality is Paraguay.

The Peccaries, as now recognized (excluding extinct forms), with their principal synonymy, stand as follows:

Genus **Tayassu** Fischer.

Tayassu G. Fischer, Zoognosia, III, 1814, 284.

Dicotyles Cuvier, Règne An. I, 1817, 237 = *Tayassu* Fischer.

Notophorus G. Fischer, Mém. Soc. Imp. des Nat. de Moscou, V, 1817, 418. Given to replace his previous barbarous name *Tayassu*.

Subgenus **Tayassu** (ex Fischer).

Tayassu Merriam, Proc. Biol. Soc. Wash. XIV, 122, July 19, 1901. "Restricted to the *tajacu-angularis* group."

Notophorus Gray, P. Z. S. 1868, 43. Type and only species, *Sus tajacu* Linn. Preoccupied by *Notophorus* Fischer, 1817 = *Tayassu* Fischer, 1814.

1. **Tayassu tajacu** (*Linn.*).

Sus tajacu Linn. Syst. Nat. 1758, 50. Based on Piso, Marcgrave, Hernandez, etc.; diagnosis distinctive for the Collared Peccary group, but references composite. First properly described and distinguished from the White-lipped Peccaries by Azara, as below; hence it would be well to recognize Paraguay as the type locality, on the basis of Azara's 'restriction.'

Le Taytétou, Sus tajassu Linn. Azara, Quad. Paraguay, I, 1801, 31. = *Sus tajacu* Linn. restricted. Not *Sus tajassu* Erxleben, Gmelin, and other early compilers, which comprised all then known Peccaries.

Sus patira Sonnini, Nouv. Dict. d'Hist. Nat. XVII, 1803, 180 = Taytétou, Azara, *l. c.* p. 31.

Tayassu patira G. Fischer, Zoognosia, III, 1814, 287 = *Sus patira* Sonnini, 1803.

Dicotyles torquatus Cuvier, Règne An. I, 1817, 237. Based on Azara as above cited, and hence also relates primarily to the Paraguayan animal.

2. **Tayassu angulatus** (*Cope*).

Dicotyles angulatus Cope, Am. Nat. Feb. 1889, 147, May 25, 1899. Texas.

3. **Tayassu angulatus sonoriensis** (*Mearns*).

Dicotyles angulatus sonoriensis Mearns, Proc. U. S. Nat. Mus. XX, No. 1129, 469 (advance sheet, Feb. 11, 1897). Sonora, Mexico.

4. **Tayassu angulatus humeralis** *Merriam.*

Tayassu angulatus humeralis Merriam, Proc. Biol. Soc. Wash. XIV, 122, July 19, 1901. Armeria, Colima, Mexico.

5. **Tayassu angulatus yucatanensis** *Merriam.*

Tayassu angulatus yucatanensis Merriam, Proc. Biol. Soc. Wash. XIV, 123, July 19, 1901. Tunkas, Yucatan.

6. **Tayassu nanus** *Merriam.*

Tayassu nanus Merriam, Proc. Biol. Soc. Wash. XIV, 102, July 19, 1901. Cozumel Island, Yucatan.

7. **Tayassu crusnigrum** *Bangs.*

Tayassu crusnigrum Bangs, Proc. Boston Soc. Nat. Hist. XXXIX, No. 2, 20, April, 1902. Boquete, Chiriqui, Panama.

8. **Tayassu torvus** *Bangs.*

Tayassu torvus Bangs, Proc. Biol. Soc. Wash. XII, 164, Aug. 10, 1898. Santa Marta, Colombia.

Subgenus **Olidosus** Merriam.

Olidosus Merriam, Proc. Biol. Soc. Wash. XIV, 120, July 19, 1902. For "the *albirostris* group."

Dicotyles Gray, P. Z. S. 1868, 45. Type, *D. labiatus* Cuvier. Preoccupied by *Dicotyles* Cuvier, 1817 = *Tayassu* Fischer, 1814.

9. **Tayassu pecari** *Fischer.*

Le Tagnicati, Azara, Quad. Parag., I, 1801, 25. Paraguay.

Tayassu pecari G. Fischer, Zoognosia, III, 1814, 285 = Tagnicati, Azara, as above cited.

Sus albirostris Illiger, Abhand. K. Akad. Wiss. Berlin, 1811 (1815), 108 = Tagnicati of Azara.

Dicotyles labiatus Cuvier, Règne An. I, 1817, 238 = Tagnicati of Azara.

10. **Tayassu pecari ringens** (*Merriam*).

Tayassu albirostris ringens MERRIAM, Proc. Biol. Soc. Wash. XIV, 121, July 19, 1901. Apazote, Campeche.

Indeterminate.

Dicotyles minor SCHINZ, Cuvier's Thierreich, IV, 1825, 511. Based on a young specimen from an unknown locality. "Vaterland? Sudamerika. (Frankfurter Museum.)"

IV. — The Proper Specific Name of the Western Fox Squirrel.

The Western Fox Squirrel was described by Custis in 1806, under the name *Sciurus ludovicianus*, and this has been supposed to be the earliest name for the species. The next name in point of date has been currently supposed to be "*Sciurus rufiventer* Geoff.," published by Desmarest in 1817 (Nouv. Dict. d'Hist. Nat., X, 1817, p. 103). As the name here stands, it is apparently a manuscript or museum name of Geoffroy's, here first published by Desmarest, and has usually been thus considered. It was, however, first published by E. Geoffroy himself in 1803 (Cat. Mus. d'Hist. Nat., 1803, p. 176), and is based on a specimen of the Western Fox Squirrel sent to him by Michaux. Desmarest apparently redescribed the same specimen. As there has never been any doubt as to the pertinency of Geoffroy's name to this animal, and as it has three years' priority over *ludovicianus* of Custis, it will have to be adopted as the specific designation of the *Sciurus ludovicianus* group.

There is, furthermore, little doubt that Bachman's name *Sciurus texianus* (P. Z. S., 1838, p. 86) should replace *Sciurus limitis* Baird (1855). While Bachman's description appears to have been based on various specimens seen in different European museums (he mentions first a specimen in the Paris Museum said to have been "received from Mexico," and another in the British Museum "obtained at Texas by Mr. Douglas," and still another as received through a friend from "the south-western part of Louisiana"), it applies satisfactorily to the Texas Fox Squirrel, and he gives its range as "extending perhaps from the south-western portions of Louisiana, through Texas into Mexico." He further says it

"would appear to replace the *capistratus* [= *S. niger* Linn.] in the south-western parts of America." While no definite type locality (a thing unknown in those days) is given, the range of Bachman's *texianus*, as stated by him, practically coincides with that of Baird's *limitis*.

With these changes the Western Fox Squirrels will stand as follows:

1. Sciurus rufiventer *E. Geoffroy.*

Sciurus rufiventer E. Geoffroy, Cat. Mus. d'Hist. Nat. 1803, 176.

Sciurus ludovicianus Custis, Barton's Med. and Phys. Journ, II, 1806, 43.

2. Sciurus rufiventer texianus (*Bachman*).

Sciurus texianus Bachman, P. Z. S. 1838, 86; Charlsworth's Mag. Nat. Hist. III, 1839, 154; Am. Journ. Sci. and Arts, XXXVII, 1839, 295.

Sciurus limitis Baird, Proc. Acad. Nat. Sci. Phila. 1855, 331.

3. Sciurus rufiventer neglectus (*Gray*).

Macroxus neglectus Gray, Ann. and Mag. Nat. Hist. (3) XX, Dec. 1867, 425.

Sciurus ludovicianus neglectus Nelson, Proc. Biol. Soc. Wash. XIII, 1900, 150.

Sciurus niger var. *cinereus* Allen, Mon. N. Am. Mamm. 1877, 718.

Sciurus ludovicianus vicinus Bangs, Proc. Biol. Soc. Wash. X, 1896, 150.

V.—Postscript.

Further Note on *Notophorus*.—Since the foregoing was passed for the press I have received pages 153–156 of Vol. XV of the 'Proceedings' of the Biological Society of Washington, dated June 20, 1902, which contain, among other notes, a short paper by Mr. Oldfield Thomas, entitled 'The Generic Names of the Peccaries, Northern Fur Seal, and Sea Leopard.' I am pleased to see that Mr. Thomas and I agree in considering *Dicotyles* to be "strictly synonymous" with *Tayassu*. I am surprised, however, at his treatment of *Notophorus*, by which, he says, "Fischer no doubt intended merely to replace his earlier but barbarous *Tayassu* by a classical term, but he happened to mention only one species belonging to it, viz.: '*Sus tajassu* Lin. Gmel.' This therefore," he continues, "would not only be its type, but would by elimination restrict *Tayassu* and *Dicotyles* to the other species mentioned in the respective original descriptions of those genera. Dr. Merriam's

Olidosus would thus not be required." He further adds: "But while Linnæus's *Sus tajacu* was the collared Peccary, Fischer's *Sus tajassu* was, as clearly shown by the synonymy in his Zoognosia, the white-lipped species, and that, therefore, must count as the type of *Notophorus*, and by elimination bring *Tayassu* on to the true *T. tajacu*." In this way he retains *Tayassu* for the Collared Peccaries and *Notophorus* for the White-lipped Peccaries.

As already shown (*antea*, pp. 162–165), this is quite different from my interpretation of the case, and it seems to me is a violation of the principle underlying his treatment of the case of *Dicotyles*. As shown above, Fischer, in the 'Zoognosia,' gave practically new names to the two species of Peccary then known, one being entirely new and the other ex Sonnini. If Fischer had mentioned either one of these names under *Notophorus* in replacing *Tayassu*, Mr. Thomas's contention would be perfectly sound. But instead of doing this he simply gave "*Sus tajassu* Lin. Gmel.," which means nothing in a type sense, because, as shown above, it is unidentifiable. As Mr. Thomas admits, it is not the *Sus tajacu* of Linnæus; if it is the *Sus tajassu* of Gmelin, it is a composite, embracing all the Peccaries then known. Furthermore, Fischer's reference, "Syst. nat. III, n. 6," does not fit either. As *Notophorus* was obviously given to replace *Tayassu*, as shown by the references under it to both *Tayassu* and *Dicotyles*, it should be treated just as Mr. Thomas treats *Dicotyles*. It would be, I think, contrary to sound principles of nomenclature to identify the bare "*Sus tajassu* Lin. Gmel." under *Notophorus* with Fischer's *Tayassu pecari* of the 'Zoognosia,' simply because Fischer in the latter connection happens to cite a "*Sus tayassu* Lin. Gmel., Syst. nat. III, n. 6," which does not occur at either place indicated, and is apparently both composite and indeterminate.

In this connection reference may be made to Mr. Thomas's remarks on the names *Callorhinus* and *Callirhinus*, and *Stenorhinchus*, *Stenorhynchus* and *Stenorynchus*, which are considered as "'permissible variants' of one compound," each valid for use in nomenclature, but only so far as to call attention to the preceding remarks (pp. 159–162) under *Alce* and *Alces*.

Article XVII. — AMERICAN EOCENE PRIMATES, AND THE SUPPOSED RODENT FAMILY MIXODECTIDÆ.

By Henry Fairfield Osborn.

The only American Primates at present known are those in the Eocene. The supposed Oligocene Primates, *Laopithecus* Marsh and *Menotherium* Cope, have proved to be identical with *Leptochœrus* Leidy, an Artiodactyl.

Invariably associated with the discovery and literature of the Primates is the family Mixodectidæ, including *Mixodectes* and possibly *Indrodon*, *Cynodontomys*, and *Microsyops*, now supposed to be very primitive Rodents. In the writings of Cope, Marsh, and Leidy, the bibliographical relations of these two groups are so intimate that it is convenient to revise them together.

Altogether fifty-one species have been named, many of them based upon defective types; the synonymy is truly appalling, as shown in the chronological table.

Many years ago I devoted several months to systematic revision as the basis of the present paper, examining and comparing the types in the collections made by Leidy, Marsh, and Cope, now in the Philadelphia Academy (Ph.), American Museum (A. M.) and Yale University (Y.). Unfortunately all the types described by Cope for the Wheeler Survey, and figured in his 'Extinct Vertebrata of New Mexico' of 1874 have disappeared. A beginning is made here by pointing out the synonymous genera but the species require prolonged and microscopic examination and comparison. This, however, is intended to supersede and replace all previous revisions by the author and his staff in the Museum.

Dr. W. D. Matthew has rendered invaluable aid and advice both in the morphological and descriptive part. In putting together these notes and tables I have also been greatly assisted by Mr. W. K. Gregory. The drawings are chiefly the work of Mr. Weber, Mr. Horsfall, and Mr. Anderson.

Part I. Primates.

I. SUPPOSED BASAL EOCENE (MONTIEN AND THANÉTIEN) PRIMATES.

None of the Basal Eocene (Puerco and Torrejon) types appear to be positively ancestral to the Lower Eocene or Wasatch Primates; the Primates of the latter stage (Sparnacien) thus far *appear to represent a new primate fauna* like the new ungulate fauna of horses, tapirs, etc.

The Puerco and Torrejon species include a great number and variety of small animals whose relationships are still largely a matter of individual opinion, because the material, except in the case of one skeleton (No. 823, see below), affords no absolutely distinctive characters. They have been referred by different authors, chiefly Cope, Schlosser, Earle, and Osborn, to such diverse orders as the Creodonta, Rodentia, Condylarthra, Insectivora, and Primates. I have always inclined to refer many of the smaller types to the Primates, but without being able to give conclusive grounds for the opinion, the main reason being the general adaptive resemblance which they bear to the existing Lemurs.

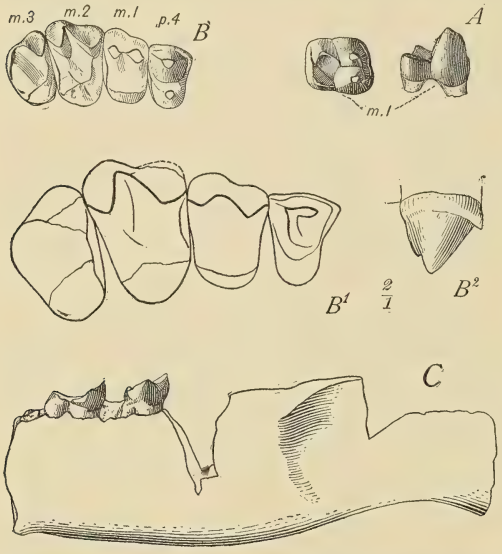


Fig. 1. *A*, *Mioclænus acolytus*. Amer. Mus. No. 829*a*. Lower molar. *B*, supposed Primate. Am. Mus. No. 823. *B*, superior molars, enlarged 2 diam., B^1, contour of same still more enlarged. *C*, lower jaw of same specimen, 2 diam. Compare Fig. 2. Twice natural size.

Indrodon malaris (Torrejon stage) was placed by Cope in the Anaptomorphidæ; this is an error. The structure of the superior

molar teeth relates it rather to *Mixodectes*, a supposed primitive Rodent.

The skeleton (Amer. Mus. No. 823) originally associated with *Indrodon* by error (Osborn and Earle, 1895, pp. 16–20) deserves most careful examination, for if it belongs to a Primate it is by far the most primitive known. The astragalus is not like that of a Rodent. The figures (Figs. 1, 2) give the proportions of the limbs.

Mioclænus acolytus and *M. lemuroides* Matthew are two other small Torrejon species in which the lower molar teeth suggest those of *Hyopsodus*, especially in the reduction of the paraconid (Fig. 1*A*).

Oxyacodon apiculatus (Puerco) and *O. agapetillus* (Puerco), also *Carcinodon filholianus* (Puerco), deserve examination in this connection.

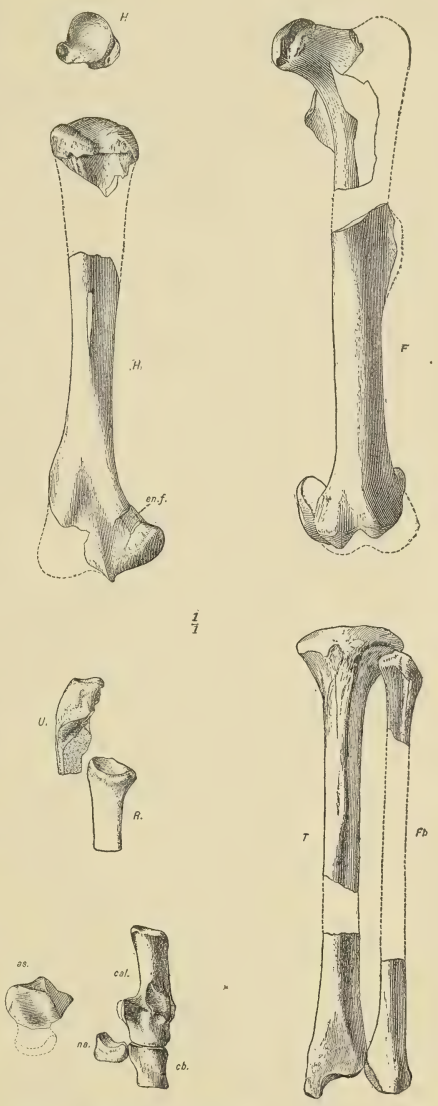


Fig. 2. Supposed Primate. Am. Mus. No. 823. Fore and hind limb bones and tarsals. All natural size. Compare Fig. 1.

CHRONOLOGICAL TABLE OF SPECIES REFERRED TO EOCENE PRIMATES

OMITTING CERTAIN PUERCO AND TORREJON STAGES.

Species Number and Reference Page in this Article.	*Original Reference.*	*Figure.*	*Type.*	*Present Location.*	*Horizon.*
(1) *Omomys carteri* Leidy, p. 190.	Proc. Acad. Sci. Phila., Apr., 1869, p. 63.	Ext. Fauna Dak. and Nebr., 1869, p. 408, pl. xxix, figs. 13 and 14.	Rt. ramus; fragment of cranium.	Ph.	Bridger.
(2) *Hyopsodus paulus* Leidy, p 185.	*Ibid.*, Oct. 4, 1870, p. 110.	Contr. Ext. Fauna West. Terr., 1873, pl. vi, figs. 1–9, 18–22.	Rt. ramus with p_4–m_3.	Ph.	Bridger.
(3) *Microsus cuspidatus* Leidy p. 180. = *Hyopsodus paulus.*	*Ibid.*, p. 113.	*Ibid.*, pl. vi, figs. 10, 11.	Part low. jaw cont. m_2, m_3.	U. S.	Bridger.
(4) *Notharctus tenebrosus* Leidy, p. 196.	*Ibid.*, pp. 113–114.	*Ibid.*, p. 86, pl. vi, figs. 36, 37.	Rt. ramus cont. c–m_3.	U. S.	Bridger.
(5) *Hyopsodus gracilis* Marsh, p. 108. =? *Sarcolemur gracilis.* Or may antedate (7)	Amer. Jour. Sci., II, 1871, p. 42; sep. "June 5, 1871," p. 10.		Part low. jaw cont. p_3, p_4, m_1.	Y.	Bridger.
(6) *Limnotherium tyrannus* Marsh, p. 197. =? *Notharctus tyrannus.*	*Ibid.*, p. 43; sep. "June 5, 1871," p. 16.		Low. jaw with several teeth.	Y.	Bridger.
(7) *Limnotherium elegans* Marsh, p. 198. =? *Notharctus elegans.*	*Ibid.*, pp. 43–44; sep. "June 5, 1871," p. 12.		Portions of rami cont. p_4 and m_1, m_3.	Y.	Bridger.
(8) *Microsyops gracilis* Leidy, p. 210.	Proc. Acad. Sci. Phila., 1872, Feb. 6, p. 20. (Publ. Apr. 16.)	*Ibid.*, pl. vi, fig. 14.	Left ramus.		Bridger. (Grizzly Buttes).
(9) *Palæacodon verus* Leidy, p. 210. =*Microsyops verus.*	*Ibid.*, p. 21.	*Ibid.*, p. 122, pl. vi, fig. 46.	Part up. jaw cont. one m.	Ph.	Bridger.
(10) *Hipposyus formosus* Leidy, p. 198. =? *Notharctus formosus.*	*Ibid.*, Apr. 2, p. 37. (Publ. June 25.)	*Ibid.*, p. 90, pl. vi, fig. 41.	Part of up. jaw cont. m^1, m^2. Cotype inf. ms.	Ph.	Bridger.
(11) *Lophiotherium* (*Hyopsodus, Sarcolemur*) *pygmæus* Cope, p. 189. =*Sarcolemur pygmæus.*	Proc. Amer. Phil. Soc., 1872, p. 461; sep. "July 29, 1872."		Part of rt. ramus cont. m_1, m_2, and p_4–m_3 emerging.	A. M. (No. 5006.)	Bridger.
(12) *Notharctus* (*Hipposyus*) *robustior* Leidy, p. 198. = *Notharctus robustior.*	Hayden's Rep. Geol. Surv. Mont., 1871 (1872), p. 364.	*Ibid.*, p. 93, pl. vi, fig. 40.	Part lower jaw with one tooth (m_2).	Ph.	Bridger.
(13) *Thinolestes anceps* Marsh, p. 197. =? *Notharctus anceps.*	Amer. Jour. Sci., IV, Sept., 1872, p. 205; sep. "Aug. 7, 1872," pp. 13–14.		Up. and low jaws, teeth, humerus, astrag., caud. vert.	Y.	Bridger.
(14) *Telmatolestes crassus* Marsh, p. 198. =? *Notharctus crassus.*	*Ibid.*, p. 206; sep. "Aug. 7, 1872," p. 14.		Sup. ms., lower jaw with teeth.	Y.	Bridger. (Henry's Fork.)
(15) *Limnotherium affine* Marsh, p. 197. =? *Notharctus affinis.*	*Ibid.*, p. 207; sep. "Aug. 7, 1872," p. 14.		Skull, teeth, lower jaw, portions of skel.	Y.	Bridger. (Grizzly Buttes.)

Species Number and Reference Page in this Article.	*Original Reference.*	*Figure.*	*Type.*	*Present Location.*	*Horizon.*
(16) *Stenacodon rarus* Marsh, p. 190. = *Hyopsodus rarus.*	*Ibid.*, p. 210; sep. "Aug. 13, 1872," p. 18.		m_3.	Y.	Bridger. (Henry's Fork.)
(17) *Antiacodon venustus* Marsh, p. 189. cf. *Homacodon* (? Artiodactyla).	*Ibid.*, p. 210; sep. "Aug. 13, 1872," p. 19.		Part low. jaw cont. m_3.	Y.	Bridger. (Henry's Fork.)
(18) *Bathrodon typus* Marsh, p. 212. = ? *Microsyops typus.*	*Ibid.*, p. 211; sep. "Aug. 13, 1872," p. 19.		Part low. jaw cont. m_1–m_3.	Y.	Bridger. (Grizzly Buttes.)
(19) *Bathrodon annectens* Marsh, p. 213. = *Microsyops annectens.*	*Ibid.*, p. 211; sep. "Aug. 13, 1872," p. 20.		Part low. jaw cont. m_3.	Y.	Bridger. (Henry's Fork.)
(20) *Mesacodon speciosus* Marsh, p. 212. = *Microsyops speciosus.*	*Ibid.*, p. 212; sep. "Aug. 13, 1872," p. 21.		Low. jaw.	Y.	Bridger. (Grizzly Buttes.)
(21) *Hemiacodon gracilis* Marsh, p. 200. =*Omomys gracilis.*	*Ibid.*, p. 212; sep. "Aug. 13, 1872," p. 21.		Part several low. jaws.	Y.	Bridger. (Henry's Fork.)
(22) *Hemiacodon nanus* Marsh, p. 200. = *Omomys nanus.*	*Ibid.*, p. 213; sep. "Aug. 13, 1872," p. 21.		Rt. ramus cont. p_4–m_3.	Y.	Bridger. (Henry's Fork.)
(23) *Hemiacodon pucillus* Marsh, p. 200. = *Omomys pucillus.*	*Ibid.*, p. 213; sep. "Aug. 13, 1872," p. 22.		Lower jaw cont. m_2.	Y.	Bridger.
(24) *Entomodon comptus* Marsh, p. 189. = ? *Sarcolemur comptus.*	*Ibid.*, p. 214; sep. "Aug. 13, 1872," p. 23.		Several isolated teeth, incl. p_4 (rt. side).	Y.	Bridger.
(25) *Pantolestes longicaudus* Cope, *Incertæ sedis.*	Proc. Amer. Phil. Soc., Aug. 15, 1872, p. 467.	Tert. Vert., 1884, p. 725, pl. xxiv, figs. 13–17.	Left ramus low. jaw, p_4–m_3 and caudals.	A. M. (No. 5142.)	Bridger.
(26) *Palæacodon vagus* Marsh, p. 200. = ? *Omomys, (Microsyops) vagus.*	Amer. Jour. Sci., IV, Sept., 1872, p. 224; sep. "Aug. 17, 1872," p. 34.		Upper jaw cont. m^1, m^2, m^3.	Y.	Bridger. (Grizzly Buttes.)
(27) *Tomitherium rostratum* Cope, p. 197. = ? *Notharctus rostratus.*	Proc. Amer. Phil. Soc., Sept. 19, 1872, p. 470; sep. Pal. Bull. No. 3, p. 3, "Aug. 7, 1872."	Tert. Vert., 1884, p. 221, pl. xxv, figs. 1–9.	Complete low. jaw with teeth. Skeleton (humerus, ulna, radius, femur, ilium).	A. M. (No. 5009.)	Bridger. (Black's Fork.)
(28) *Anaptomorphus æmulus* Cope, p. 202.	Proc. Amer. Phil. Soc., Oct. 18, 1872, p. 554; sep. Pal. Bull., No. 8, p. 1, "Oct. 12, 1872."	Tert. Vert., 1884, p. 248, pl. xxv, fig. 10.	Left ramus, p_4–m_2 and alveoli of front teeth.	A. M. (No. 5010.)	Bridger. (Green River.)
(29) *Hyopsodus minusculus* Leidy, p. 186.	Contr. Ext. Fauna West. Terr., 1873, p. 81.	Contr., etc., pl. xxvii, fig. 5.	Part up. jaw cont. several ms.	Ph.	Bridger. (Dry Creek.)
(30) *Washakius insignis* Leidy, p. 200. *Incertæ sedis* (? Rodentia).	*Ibid.*, p. 123.	Contr., etc., pl. xxvii, figs. 3, 4.	Part low. jaw cont. m_2, m_3.	Ph.	Bridger.
(31) *Antiacodon furcatus* Cope, p. 189. = *Sarcolemur furcatus.*	Ann. Rep. Geol. Surv. Terr. (Hayden), 1872 (1873), p. 608.	Tert. Vert., 1884, p. 233, pl. xxiv, figs. 18, 19.	Part rt. ramus cont. p_4–m_3.	A. M. (No. 5008.)	Bridger. (Bluffs of Upper Green River.)
(32) *Microsyops (Hyopsodus) vicarius* Cope, p. 187. = *Hyopsodus vicarius.*	*Ibid.*, p. 609.	Tert. Vert., 1884, p. 237, pl. xxiv, figs. 20, 21; pl. xxva, fig. 7.	Two fragments of jaws.	A. M. (No. 5003.) (Cotype No. 5004.)	Bridger. (Cottonwood Creek.)

Species Number and Reference Page in this Article.	*Original Reference.*	*Figure.*	*Type.*	*Present Location.*	*Horizon.*
(33) *Menotherium lemurinum* Cope, p. 169. = *Leptochœrus lemurinus* (? Artiodactyla).	Bull. U. S. Geol. Surv., Series 1, Vol. 1, No. 1, Jan., 1874, p. 22. Proc. Acad. Sci. Phila., Feb. 17, 1874, p. 419. (Read Dec. 23, 1873.)		Low. jaws, pms. and ms.	A. M. (No. 5349.)	White River. (Colorado.)
(34) *Esthonyx* (*Hyopsodus*) *miticulus* Cope, p. 183. = *Hyopsodus miticulus.*	Rept. Vert. Foss. disc. in New Mexico, Extr. Appendix FF., Ann. Rept. Chief of Engineers, Survey West of 100 Merid., Wheeler, 1874, "Nov. 28, 1874," p. 8. Syst. Cat. Vert. Eoc., New Mex., Surv. West of 100 Merid., Wheeler, "Apr. 17, 1875," p. 18.	*Ibid.*, p. 150, pl. xlv, figs. 10–12.	Rami and teeth.	U. S.	Wasatch. (New Mex.)
(35) *Prototomus* (*Pelycodus*) *jarrovii* Cope, p. 193. = *Pelycodus jarrovii.*	Rept. Vert. Foss. disc. in New Mexico, Extr. Appendix FF., Ann. Rept. Chief of Engineers, Survey West of 100 Merid., Wheeler, 1874, "Nov. 28, 1874," p. 14. Syst. Cat. Vert. Eoc. New Mex., Surv. of 100 Merid., Wheeler, "Apr. 17, 1875," p. 14.	Final Rept. Surv. West of 100 Merid., Vol. IV, 1877, pl. xxxix, figs. 17, 18; pl. xlv, figs. 1–15.	Rt. ramus cont. pms. and ms., portions of skel.	U. S.	Wasatch. (New Mex.)
(36) *Lemuravus distans* Marsh, p. 187. = *Hyopsodus distans.*	Amer. Jour. Sci., IX, March, 1875, p. 239.		Teeth, jaw, parts skull and skel., brain cast.	Y.	Bridger.
(37) *Laopithecus robustus* Marsh, p. 169. = *Leptochœrus robustus* (Artiodactyla).	Amer. Jour. Sc., IX, March, 1875, p. 240.	Amer. Jour. Sci., XLVI, 1893, pp. 407–412, pl. x, fig. 5.	Ramus cont. m_1–m_3.	Y.	White River.
(38) *Pelycodus* (*Tomitherium*) *frugivorus* Cope, p. 193.	Syst. Cat. Vert. Eoc. New Mex., Surv. West of 100 Merid., Wheeler, "Apr. 17, 1875," p. 14.	Final Rept. Surv. West of 100 Merid., Vol. IV, 1877, p. 144, pl. xxxix, fig. 16.	Ramus cont. m_2–m_3.	U. S.	Wasatch. (New Mex.)
(39) *Pelycodus angulatus* Cope, p. 202. *Indeterminate.*	*Ibid.*, p. 14.	*Ibid.*, p. 144, pl. xxxix, fig. 15.	Part rt. ramus cont. one m., an isolated m.	U. S.	Wasatch. (New Mex.)
(40) *Antiacodon* (*Sarcolemur*) *mentalis* Cope, p. 191. cf. *Pelycodus. mentalis.*	*Ibid.*, p. 17.	*Ibid.*, p. 149, pl. xlv, fig. 15.	Ramus cont. m_1, m_2.	U. S.	Wasatch. (New Mex.)
(41) *Antiacodon* (*Sarcolemur*) *crassus* Cope, p. 189. = *Sarcolemur crassus.*	*Ibid.*, p. 17.	*Ibid.*, p. 149, pl. xlv, fig. 16.	Part rt. ramus cont. m_1, m_2.	U. S.	Wasatch. (New Mex.)
(42) *Sarcolemur* (*Antiacodon*) *furcatus* Cope, p. 189.	Proc. Acad. Sci. Phila., May 11, 1875, p. 256.	Tert. Vert., 1884, pl. xxiv, figs. 18–19.	See species (31).	A. M. (No. 5008.)	Bridger. (Green River.)
(43) *Tomitherium* (*Pelycodus*) *tutus* Cope, p. 194. = *Pelycodus tutus.*	Final Rept. Surv. West of 100 Merid., 1877, IV, p. 141.	Final Rept. Surv. West of 100 Merid., 1877, pl. xxxix, fig. 19; xl, figs. 16–25.	Part lower jaw with two pms. and one m.; fragments skel.	U. S.	Wasatch. (New Mex.)

Species Number and Reference Page in this Article.	*Original Reference.*	*Figure.*	*Type.*	*Present Location.*	*Horizon.*
(44) *Microsyops speirianus* Cope, p. 210. = ? *Anaptomorphus speirianus.*	Amer. Nat., XIV, Dec., 1880, p. 908. Tert. Vert., 1884, p. 216.	Tert. Vert., pl. xxva, fig. 8.	Part rt. ramus with m_1–m_3.	A. M. (No. 4190.)	Wind River.
(45) *Pelycodus nunienus* Cope, p. 195.	Bull. U. S. Geol. Surv. Terr., Hayden, Vol. VI, Feb. 11, 1881, p. 187.		Right ramus, p_3–m_3.	A. M. (No. 4734.)	Wind River.
(46) *Microsyops scottianus* Cope, p. 209.	Bull. U. S. Geol. Surv. Terr., Hayden, Vol. VI, Feb. 11, 1881, p. 188. Tert. Vert., 1884, p. 217.	*Ibid.*, pl. xxiva, fig. 26.	Left ramus, p_4 and broken m_2.	A. M. (No. 4748.)	Wind River.
(47) *Anaptomorphus homunculus* Cope, p. 200.	Amer. Nat., Jan., 1882, p. 73. Proc. Amer. Philos. Soc., Vol. XX, 1881 (March 11, 1882), p. 152.	*Ibid.*, 1884, p. 249, pl. xxive, fig. 1.	Cranium (nearly entire).	A. M. (No. 4194.)	Wasatch. (Big Horn.)
(48) *Hyopsodus lemoinianus* Cope, p. 183.	Proc. Amer. Philos. Soc., Vol. XX, 1881 (Mar. 11, 1882), p. 148. Pal. Bull. No. 34, p. 148, "Publ. Febr. 20, 1882."	*Ibid.*, p. 236, pl. xxive, figs. 8, 9.	9 rami of low. jaws (fragmentary) of which Cope selected as type No. 4139.	A. M. (No. 4139.)	Wasatch. (Big Horn.)
(49) *Cynodontomys latidens* Cope, p. 208. = ? *Microsyops latidens.*	Proc. Amer. Philos. Soc., Vol. XX, 1881 (Mar. 11, 1882), p. 151. Sep. Pal. Bull., No. 34, "Feb. 20, 1882," p. 151.	*Ibid.*, 1884, p. 244, pl. xxive, fig. 22.	Rami, m_1, m_2r, p_4l.	A. M. (No. 4195.)	Wasatch. (Big Horn.)
(50) *Diacodexis* (*Phenacodus*) *laticuneus* Cope, p. 184. (? Artiodactyla, cf. *H. powellianus*).	Proc. Amer. Philos. Soc., Vol. XX, 1881 (Mar. 11, 1882), p. 181. Sep. Pal. Bull, No. 34, Feb. 20, 1882, p. 181. Amer. Nat., Dec., 1882, p. 1029.	*Ibid.*, 1884, p. 492, pl. xxve, figs. 17–18.	Three superior molars and last inferior molar in a fragment of lower jaw.	A. M. (No. 4202.)	
(51) *Mixodectes pungens* Cope, p. 206.	Proc. Amer. Philos. Soc., 1882–3, p. 559.	Tert. Vert., p. 241, pl. xxivf, fig. 1.	Right ramus.	A. M. (No. 3081.)	Torrejon.
(52) *Mixodectes crassiusculus* Cope, p. 207.	*Ibid.*, p. 559.	*Ibid.*, pl. xxivf, fig. 2.		A. M. (No. 3087.)	Torrejon.
(53) *Hyopsodus powellianus* Cope, p. 184. = ? *D. laticuneus.*	Tert. Vert., 1884, p. 235.	*Ibid.*, pl. xxiiid, figs. 3, 4.	11 rami, of which Cope selected as type at time of cataloguing in 1896 one with m_1–m_3, r.	A. M. (No. 4147.)	Wasatch. (Big Horn.)
(54) *Microsyops uintensis* Osborn, p. 202.	Bull. Amer. Mus. Nat. Hist., VII, 1895, p. 77.	Bull. Amer. Mus., etc., VII, fig. 1, p. 77.	Part left ramus.	A. M. (No. 1899.)	Uinta.
(55) *Hyopsodus wortmani* Osborn, p. 185.	*This Bull.*, p. 185.	*This Bull.*, fig. 11.	Mx. and pmx., i^2, c–m^3.	A. M. (No. 4716.)	Wind River
(56) *Hyopsodus marshi* Osborn, p. 187.	*Ibid.*, p. 187.	*Ibid.*, fig. 13.	Maxillæ containing p^2, m^3.	A. M. (No. 1706a.)	Bridger.
(57) *Hyopsodus uintensis* Osborn, p. 187.	*Ibid.*, p. 187.	*Ibid.*, fig. 14.	R. max., p^4–m^3.	A. M. (No. 2079.)	Uinta.
(58) *Notharctus venticolus*, p. 195.	*Ibid.*, p. 195.	Tert. Vert., pl. xxva, figs. 1, 2.	Upper and lower molars.	A. M. (No. 4715b.)	Wind River.
(59) *Olbodotes copei* Osborn, p. 205.	*Ibid.*, p. 205.	*Ibid.*, fig. —.	Fragm. ramus, c_1–m_3.	A. M. (No. 2385.)	

II. LOWER, MIDDLE, AND UPPER EOCENE PRIMATES.

(SPARNACIEN, YPRÉSIEN, LUTÉTIEN, BARTONIEN, LIGURIEN.)

Originating in the lower Eocene or Wasatch (Sparnacien, Yprésien) of North America are found three phyla of Primates, quite distinct from those in Europe.

1. The HYOPSODONTIDÆ are analogous in certain respects of molar tooth structure to the Microchœridæ of Europe, but are distinct in the simple cutting teeth.

2. The NOTHARCTIDÆ resemble in size and general form the contemporaneous Adapidæ of Europe, but the much more complex structure of the upper molars constitutes good grounds for not placing them in the same family.

3. The very specialized ANAPTOMORPHIDÆ so far as known (skull, teeth and jaws only) remotely resemble the living

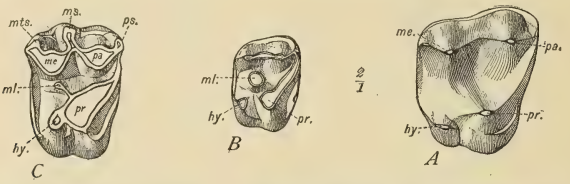


Fig. 3. Superior molars. *A*, *Adapis magnus*; *B*, *Hyopsodus uintensis*, type; *C*, *Notharctus* sp.

Tarsiidæ of the Oriental region, but it seems to be a premature conclusion to place them in the same family because they are so widely separated geologically and geographically.

The European Eocene Primates, also placed in three families, Adapidæ, Microchœridæ, and Plesiadapidæ, are now generally (Trouessart, '97) referred to the Lemuroidea. The force of Schlosser's remark ('87, p. 19) uniting them in the distinct suborder Pseudolemuroidea ("This suborder includes only extinct forms, which certainly mark a transition between the true Monkeys and Lemurs, but stand in direct genetic relations neither with one nor the other") has been vigorously disputed by Leche ('96), who, on the ground of resemblances in milk succession, places certain of these families (Microchœridæ) in the Lemuroidea.

It may be possible with the material now in hand to

positively determine the relationships of some of these forms to the existing Anthropoidea or Lemuroidea; but it will require detailed investigation, which I am not able to undertake at present.[1]

Three suppositions are possible: First, that these Primates represent an ancient and generalized group (Mesodonta, Cope) ancestral to both Lemuroidea and Anthropoidea; second, that they include representatives of both Lemuroidea and Anthropoidea, contemporaneous and intermingled; third, that they belong exclusively to one or the other order. There are certain advantages in the revival of the term Mesodonta Cope, a suborder (anticipating the terms Pseudolemuroidea and Tarsii) which would bear somewhat the same relationship to the modern specialized Monkeys and Lemurs that the Condylarthra bear to the Ungulata and the Creodonta to the Carnivora. The serious difficulty with this view is the very considerable separation of these families.

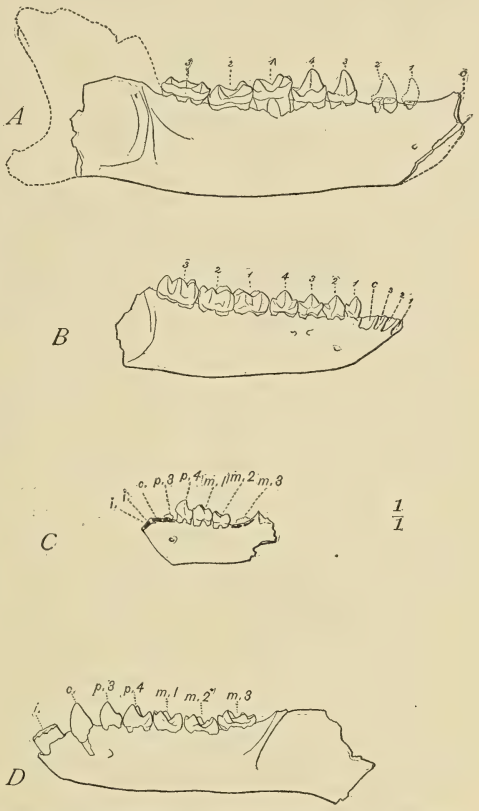


Fig. 4. Jaw outlines. All natural size. *A*, *Pelycodus tutus*; *B*, *Hyopsodus paulus*; *C*, *Anaptomorphus æmulus*; *D*, *Microsyops*.

[1] Dr. J. L. Wortman is now taking up these problems with the rich materials afforded by the Yale Museum Collections. I therefore omit phylogenetic questions here.

The extensive material in the American Museum is at the disposal of any thoroughly competent investigator who desires to exhaustively study this group. The present revision, while not final, will certainly be of service.

GEOLOGICAL DISTRIBUTION.

Partial List of Species.	Puerco.	Torrejon.	Wasatch.	Wind River.	Bridger.	Uinta.
HYOPSODONTIDÆ.						
Hyopsodus miticulus	....	....	×			
" *lemoinianus*	....	....	×			
" *powellianus*	....	....	×			
" *wortmani*	....	....	....	×		
" *paulus*	....	....	....	....	×	
" *minusculus*	....	....	....	....	×	
" *distans*	....	....	....	....	×	
" *uintensis*	....	....	....	....	....	×
Sarcolemur pygmæus	....	....	....	....	×	
" *furcatus*	....	....	....	....	×	
NOTHARCTIDÆ.						
Pelycodus jarrovii	....	....	×			
" *frugivorus*	....	....	×			
" *tutus*	....	....	×			
Notharctus nunienus	....	....	....	×		
" *tenebrosus*	....	....	....	....	×	
" *tyrannus*	....	....	....	....	×	
" *anceps*	....	....	....	....	×	
" *affinis*	....	....	....	....	×	
" *crassus*	....	....	....	....	×	
ANAPTOMORPHIDÆ.						
Anaptomorphus homunculus	....	....	×			
" *æmulus*	....	....	....	....	×	
" *? uintensis*	....	....	....	....	....	×

ORDER MESODONTA COPE.

Pachylemuriens Filhol, in part; *Pseudolemuroidea* Schlosser, in part; *Tarsii* Gill, in part.

Characters: Primitive Primates. Incisors typical or reduced to $\frac{2}{2}$; canines typical or enlarged, premolars $\frac{4}{4}$ to $\frac{2}{2}$; molars $\frac{3}{3}$; upper molars ranging from trituberculy to sexituberculy; lower molars ranging from quinquetuberculy (tuberculo-sectorial) to quadrituberculy. Lachrymal

foramen external or internal to orbit. Orbits opening into temporal fossæ, with or without postorbital bar. Humerus with entepicondylar foramen.

The American forms divide into three contemporaneous phyla as follows:

1. *Hyopsodontidæ* Schlosser.	2. *Notharctidæ* Osborn.	3. *Anaptomorphidæ* Cope.
i. $\frac{3}{3}$, c. $\frac{1}{1}$, p. $\frac{4}{4}$, m. $\frac{3}{3}$=44.	i.? $\frac{3-2}{3-2}$, c. $\frac{1}{1}$, p. $\frac{4}{4}$, m. $\frac{3}{3}$=40;	i. $\frac{2}{2}$, c. $\frac{1}{1}$, p. $\frac{2}{3-2}$, m. $\frac{3}{3}$=$36-32$.
Mesaticephalic. Lachrymal canal marginal or internal to orbit. Dental series not crowded. Premolars slowly reduced. Superior molars becoming sexitubercular, quadrate. Talonid elevated, with pointed cusps. No postorbital bar.	Dolichocephalic. Premolars persistent. Superior molars triangular to quadrate, tritubercular, progressively sexitubercular. Inferior molars with depressed, crenulate talonid.	Brachycephalic. Lachrymal canal external to orbit. Dental series reduced and compressed. Premolars rapidly reduced. Superior molars tritubercular, transversely extended. Short deep jaw. A postorbital process.

Family **HYOPSODONTIDÆ** Schlosser.

Lemuravidæ [1] Marsh.

Definition.—Dentition with slight or no reduction, incisors and canines normal; canines slightly enlarged in males; superior molars progressive from tri- to sexituberculy, with progressive external cingulum, but without mesostyle; inferior molars evolved from quinque- to quadrituberculy by reduction of paraconid; inferior molars with hypoconulid; external cusps progressively opposite; pointed cusps both on talonid and trigonid. Lachrymal foramen marginal or within orbit. Skull without postorbital bar.

Analogous to the Microchœridæ and *Necrolemur* in sexitubercular superior molars; differing in typical incisor and canine teeth. Analogous to the Adapidæ in typical incisors and canines; differing in sexitubercular evolution of molars.

Chronological List.

Species of Hyopsodus.

(2) *Hyopsodus paulus* Leidy.....Bridger.
(3) " (*Microsus*) *cuspidatus* Leidy..... "
(16) ? " (*Stenacodon*) *rarus* Marsh..... "

[1] The genus *Lemuravus* is a synonym of *Hyopsodus*.

(29)		*Hyopsodus minusculus* Leidy		Bridger.
(32)		"	(*Microsyops*) *vicarius* Cope	"
(34)		"	(*Esthonyx*) *miticulus* Cope	Wasatch.
(36)		"	(*Lemuravus*) *distans* Marsh	Bridger.
(48)		"	*lemoinianus* Cope	Wasatch.
(50)	?	"	(*Phenacodus, Diacodexis*) *laticuneus* Cope	"
(53)		"	*powellianus* Cope	"
(55)		"	*wortmani* Osborn	Wind River.
(56)		"	*marshi* Osborn	Bridger.
(57)		"	*uintensis* Osborn	Uinta.

Species of Sarcolemur.

(11)		*Sarcolemur* (*Hyopsodus*) *pygmæus* Cope		Bridger.
(31)		"	(*Antiacodon*) *furcatus* Cope	"
(41)		"	(*Antiacodon*) *crassus* Cope	"
(5)	?	"	(*Hyopsodus*) *gracilis*, Marsh	"
(24)	?	"	(*Entomodon*) *comptus* Marsh	"

This family embraces a great variety of middle-sized Primates extending from the Wasatch (Suessonien) to the Uinta (Ligurien) divided into two readily distinguishable genera, *Hyopsodus* Leidy and *Sarcolemur* Cope.

Hyopsodus.	*Sarcolemur.*
Paraconid typically wanting.	Paraconid persistent, close to metaconid.

A single specimen (Am. Mus. No. 4192) of *Hyopsodus* exhibits a vestigial paraconid and bridges the gap between these genera.

Genus HYOPSODUS Leidy.

Microsus Leidy, *Lemuravus* Marsh, ? *Stenacodon* Marsh. Compare also *Diacodexis laticuneus* Cope.

Hyopsodus is one of the most abundant and persistent of the Mesodonta, extending from the Wasatch to the Bridger and even into the Uinta. It was first described by Leidy in 1870 from a lower jaw found near Fort Bridger; the types of *Microsus* Leidy and *Lemuravus* Marsh, also from the Bridger, appear to be generically identical with it. *Lemuravus* was mistakenly separated by the formula i $\frac{3}{3}$, a character which is common to all the known species of *Hyopsodus*. This is the only Primate with the complete eutherian dentition known, namely : $\frac{3}{3}$, $\frac{1}{1}$, $\frac{4}{4}$, $\frac{3}{3}$ = 44. The

narrow form and pointed cusps of the lower molars, both upon talonid and trigonid, readily distinguish the members of this family from the Notharctidæ. All the known species include animals of small size.

Hyopsodus does not show a progressive increase in size; for example, the largest Wasatch species, *H. powellianus*, (Fig. 9) is larger than the largest known Bridger species.

Premolar and molar transformation.—Bridger species of Ungulates, and in fact of all bunodont mammals, are generally more complex in dentition than Wind River species, and invariably far more complex than Wasatch species, so we cannot agree with Cope in identifying Wasatch specimens of *Hyopsodus* with typical Bridger species such as *H. paulus*. The species therefore require thorough rearrangement according to geological succession and the law of progressive complication of the molar and premolar teeth.

The grinding teeth gradually become more complex, homoplastic with those of Ungulates. The upper molars progress from a triangular, tritubercular condition with a rudimentary hypocone to a quadrate, sexitubercular condition with a prominent hypocone (Bridger and Uinta); the external cingulum increases in strength until it entirely extends across the outer surface of the crown (*H. marshi*); it does not develop a mesostyle. The upper premolars progress by the addition of internal cusps; the fourth upper premolar has an internal cusp (deuterocone) in the Wasatch specimens; the fourth, third, and second have internal cusps in the upper Bridger specimens. The third and fourth lower premolars are similarly transformed, but less rapidly.

If we should follow the same principle as that which obtains among the horses, the species of *Hyopsodus* in successive geological stages might well be separated as genera but it would not subserve clearness to do this.

1. Wasatch (Sparnacien, Yprésien) Stage.

Common characters of the Wasatch species.—Superior molars sub-triangular with hypocone depressed and rudimentary or

feebly developed; fourth superior premolar only with a well developed internal cusp or deuterocone, third superior premolar with a small deuterocone, no trace of paraconid on

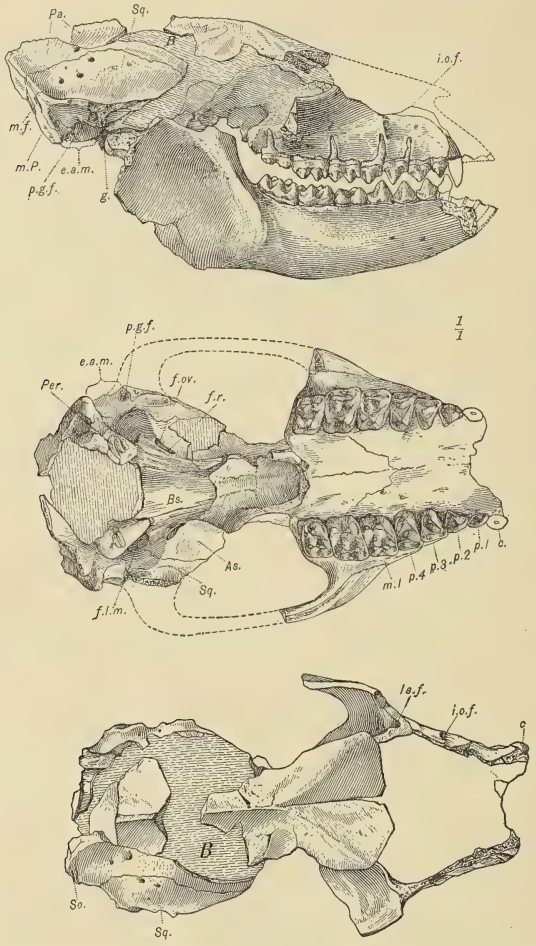


Fig. 5. *Hyopsodus paulus.* Am. Mus. No. 2301. Lateral, palatal, and superior views of skull. See page 186. Natural size.

lower molars except as an occasional vestige on m_1; this is a remarkably early specialization of these Primates towards a quadritubercular type and readily distinguishes them from the contemporary Notharctidæ, and Anaptomorphidæ. The

hypoconulid indicated on all the lower molars, is strongly developed as a posterior spur on m^3.

(Sp. 34) **Hyopsodus (Esthonyx) ? miticulus** *Cope.* Measurements in the type are: three inferior molars = 12 mm.; this species may include the small Wasatch specimens which Cope has referred to *H. vicarius* and *H. paulus* (both Bridger species) in which the molars vary from 10 mm. to 12 mm. The identification of these very small jaws and teeth with *H. miticulus* is provisional. The best preserved specimen (Am. Mus. No. 4128) shows an exceptionally reduced third superior molar (Fig. 6).

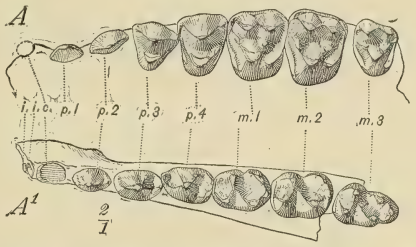


Fig. 6. *Hyopsodus ? miticulus.* Am. Mus. Cope, No. 4128. Twice natural size.

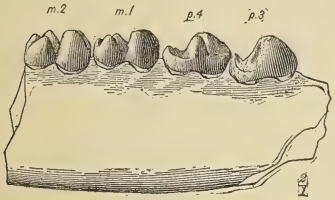


Fig. 7. *Hyopsodus lemoinianus.* Type: Am. Mus. Cope, No. 4139. Left ramus, internal view. Twice natural size.

(Sp. 48) **Hyopsodus lemoinianus** *Cope.* — Measurements of three inferior molars estimated at 15 mm. This species includes the middle-sized individuals collected in the Wasatch of Wyoming, namely, No. 4139, which is the first figured specimen or

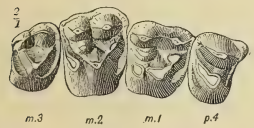


Fig. 8. *Hyopsodus lemoinianus.* Am. Mus. No. 4100. Twice natural size.

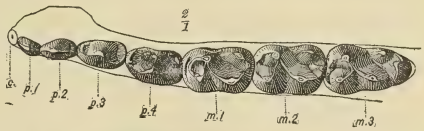


Fig. 7*a*. *Hyopsodus lemoinianus.* Am. Mus. No. 1. Twice natural size.

type, and Nos. 4140, 4138, as well as many of the specimens referred by Cope to *H. paulus* and *H. vicarius*. No satisfactory specific distinction can be given at present. This may include specimens ranging as follows: m_1–m_3 = 13 to 15 mm.

(Sp. 53) **Hyopsodus powellianus** *Cope.* — Measurements of three inferior molars in the type: 18 mm. This includes the robust jaws and teeth, namely, Am. Mus. Coll., the type No. 4147, and Nos. 4148, 4150, 4151, 4152. These are as large as, or larger than, the largest species known from the Bridger; the $m_1 - m_3 = 16$ to 18 mm.

(Sp. 50) **? Hyopsodus (Diacodexis) laticuneus** resembles

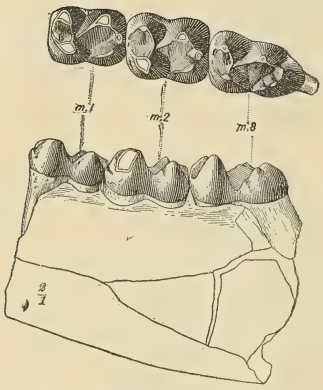


Fig. 9. *Hyopsodus powellianus.* Am. Mus. No. 4147. Slightly less than twice natural size.

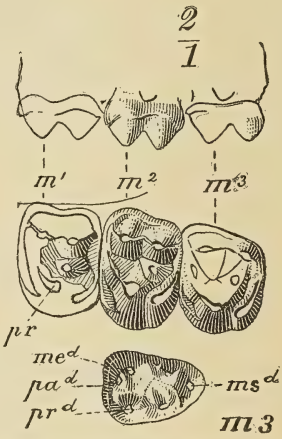


Fig. 10. *Diacodexis laticuneus.* Type. Am. Mus. No. 4202. Twice natural size.

this species in size but differs in the presence of a paraconid. This type is, however, of uncertain reference.

Dr. Matthew has observed that these species may be arranged in three groups, including larger and smaller jaws in each group, which may represent successive stages of development in a long geological age; these differences of size may however represent males and females respectively.

2. Wind River (Lutétien) Stage.

Common characters of the Wind River species.—Hyopsodus is represented by a large number of specimens from the Wind River beds which Cope mistakenly referred to the Bridger species *H. paulus* and *H. vicarius.* The superior molar teeth

are somewhat more primitive than those found in the Bridger in the more triangular shape and less prominent development of the hypocone. The hypocone is stronger than in the Wasatch specimens and both third and fourth premolars exhibit deuterocones. It is therefore probable that there are valid specific differences between these animals and the overlying Bridger species.

(Sp. 55) **Hyopsodus wortmani,** sp. nov.

Type No. 4716, Am. Mus. (figured by Cope as *H. vicarius*), Fig 11. is valuable because it shows a complete maxilla and premaxilla, the latter with three incisors of which the median pair is possibly slightly enlarged; the crown of the second incisor preserved is pointed. Third superior premolar narrow with a deuterocone. Superior ms = 10 mm. Inferior pms–ms = 21 mm.

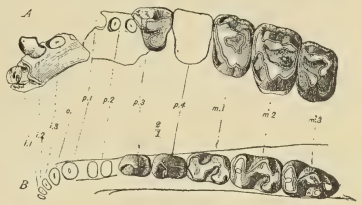


Fig. 11. *Hyopsodus wortmani.* Type. Am. Mus. Cope, No. 4716. Superior and inferior teeth. Twice natural size.

The best specimens in the American Museum collection are Nos. 4716, 4712. Inferior true molars measure 11 to 13 mm.

A slightly larger and somewhat different variety is represented by Nos. 4701, 4715, 4732.

3. Bridger (Bartonien) Stage.

As shown in the chronological list above, six species have been named from this formation and the synonomy can only be cleared up by exact comparison of the types. Deuterocones begin to appear on the second as well as the third and fourth upper premolars; hypocones are still more prominent. The Bridger specimens show a more or less decided external cingulum in the upper molars.

(Sp. 2) **Hyopsodus paulus.**— This includes the species of middle size, inferior molars = 14 mm. With this should be compared the type of (3) *H.* (*Microsus*) *cuspidatus* Leidy, also of (16) *Stenacodon rarus* Marsh; also of (32) *H.* (*Microsyops*) *vicarius* Cope.

Skull of Hyopsodus.—The most beautiful specimen in the collection consists of a skull and jaws of *Hyopsodus* (Fig. 5), collected during the American Museum expedition of 1895 by Dr. J. L. Wortman. Unfortunately the anterior region of the orbit is fractured, but on the left side the lachrymal foramen is seen to be marginal or internal as in the Anthropoidea and not external as in many of the Lemuroidea; the infraorbital foramen is placed above the interval between the third and fourth premolars; the temporal fossa is surmounted by a thin sagittal crest, which is broken away in this specimen. The external auditory meatus is widely open inferiorly, and there is no trace of a tympanic tube (the absence of a tympanic tube distinguishes the South American from the European monkeys); the bulla is also broken away, exposing a portion of the semicircular canals. Behind the auditory meatus is apparently a narrow exposure of the mastoid, perforated by the mastoid foramen; the posterior nares open just behind the last molar.

Dentition. — The last molar is a small tooth with a small hypocone, the first and second molars have the hypocone better developed. Unlike *H. marshi*, the third and fourth premolars only have internal cusps (deuterocones), the second premolar has an internal basal cingulum, the first is a simple conical tooth; close in front of this is the canine, a much larger tooth. The grinding series do not converge anteriorly, being nearly parallel; this is an important point. There is a faint external cingulum.

The lower jaw. — The inferior molars measure 14 mm; they cannot be distinguished from those of *H. paulus;* the animal was thus a small one. The fourth lower premolar presents a deuteroconid, the third premolar presents a rudiment of the same, the second and first are absolutely simple. The jaw has a well marked masseteric fossa, the condyle is raised somewhat above the level of the molar series, the chin is not very distinctly defined, the mandibular symphysis is coössified.

(Sp. 29) **Hyopsodus minusculus** *Leidy.*— This appears to be

the smallest representative of the genus in this geological stage.

(Sp. 32) **Hyopsodus vicarius** *Cope.*—The type of this species (Amer. Mus. 5003) is a single worn molar tooth, very uncharacteristic. We have provisionally associated with it a finely preserved jaw, Am. Mus. Coll., No. 1730, Fig. 12.

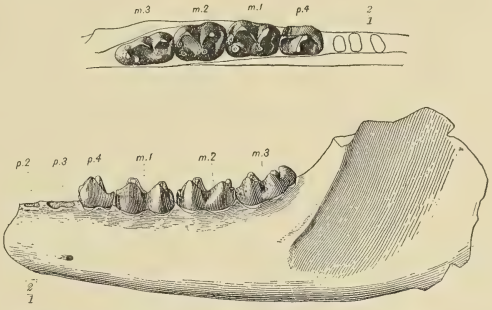


Fig. 12. *Hyopsodus? vicarius.* Am. Mus. No. 1730. Slightly less than twice natural size.

(Sp. 36) **Hyopsodus (Lemuravus) distans** *Marsh.*— A small animal; inferior true molars = 12.5 mm. In separating this genus Marsh mistakenly supposed that the true *Hyopsodus* had but two superior incisors. The coössification of the symphysis is possibly a valid specific distinction of *H. distans* from *H. paulus* in which the jaws are usually found with the symphyses imperfect; the symphysis is lacking in the *H. paulus* type but coössified in the skull described above, so that the present character of this species is entirely a matter of conjecture.

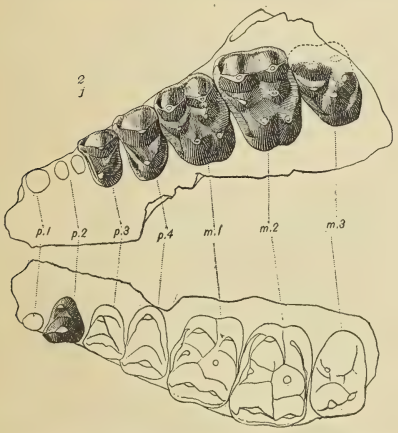


Fig. 13. *Hyopsodus marshi.* Am. Mus. No. 1706*a*. Slightly less than twice natural size. Dental series too convergent in figure.

(Sp. 56) **Hyopsodus marshi,** sp. nov.

Among the Bridger specimens in the American Museum is a pair of upper jaws (No. 1706 *a*) with a very perfectly

preserved molar series which may be taken as the type of a new species. It is probably from the upper Bridger (Fig. 13). The second, third, and fourth superior premolars show well developed internal cusps, thus differing widely from the Wasatch and Wind River specimens. The superior molars ($m^1 - m^3 = 13$ mm.) are quadrate with a well developed hypocone now almost as prominent as the protocone; the para- and metacones are conic and there is no trace of a mesostyle.

4. Uinta (Ligurien) Stage.

The genus in this stage is represented by three specimens: two parts of jaws, Nos. 2078, 2078a, also the molar series No. 2079, which unmistakably belongs to *Hyopsodus*, but indicates a new species.

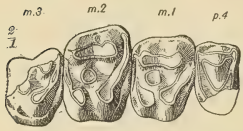


Fig. 14. *Hyopsodus uintensis.* Am. Mus. No. 2079. Twice natural size. Type.

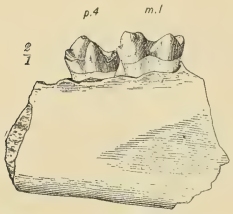


Fig. 15. *Hyopsodus uintensis.* Am. Mus. No. 2078*a*. Twice natural size.

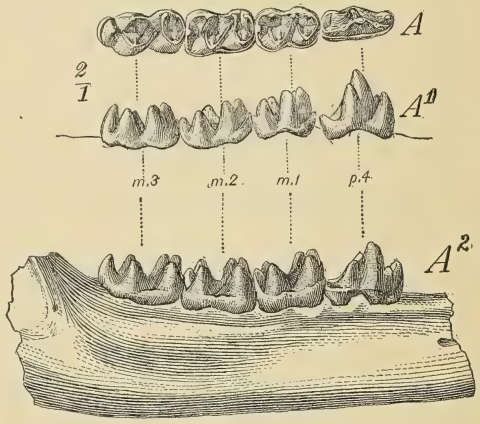


Fig. 16. *Sarcolemur furcatus.* Type. Am. Mus. Cope, No. 5008. *A*, superior, A^1, internal, A^2, external views of teeth and jaw. Twice natural size.

(Sp. 57) **Hyopsodus uintensis,** sp. nov.

Type No. 2079, Am. Mus. A right maxilla containing p^4–m^3. Superior molars with broad, well defined external cingulum, but no mesostyle; m^1–$m^3 = 12.5$ mm. Hypocone feeble or wanting on m^3. The level is Horizon C or the upper true Uinta beds of Utah.

Genus SARCOLEMUR Cope.

Entomodon Marsh, *Antiacodon* Cope.

1. Bridger (Bartonien) Stage.

The type of the genus is the jaw of the species *S.* (*Antiacodon*) *furcatus* Cope, belonging to an animal about the same size as *Hyopsodus paulus* but well distinguished by the presence of a prominent paraconid which is closely connate with the metaconid, also by the more crescentic form of the external cusps (protoconid and hypoconid), and by the more elongate form of the fourth premolar (Fig. 16). Three inferior molars = 15 mm.

S. pygmæus Cope.	*S. furcatus* Cope.
P_4 simple, lacking internal cusp.	P_4 complex, elongate, with prominent internal cusp.

(Sp. 11) **Sarcolemur pygmæus** *Cope.*—This species, from the Bridger basin of Wyoming, was originally referred by Cope to *Hyopsodus*. It bears a superficial resemblance to *Microsyops* but the simple structure of p_4 and the more elevated and connate para- and metaconids readily distinguish it; the hypoconulid on m_1 and m_2 is quite distinct as in *Hyopsodus*, enabling us to readily distinguish this type of molar from that of *Anaptomorphus*.

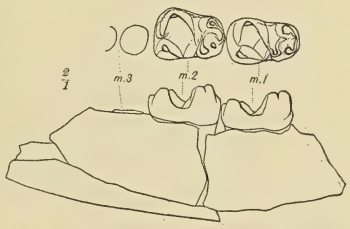


Fig. 17. *Sarcolemur pygmæus.* Co-type. Am. Mus. No. 5007. Left ramus, internal and superior views. Twice natural size.

(Sp. 31) **Sarcolemur furcatus** *Cope.*— Represented by the type lower jaw in the American Museum (No. 5008) containing the fourth premolar and three molars. With this should be compared the prior type of (Sp. 24) *Entomodon comptus* Marsh, a fourth lower premolar closely resembling that of *Sarcolemur;* if identical *Entomodon* has priority.

Family **NOTHARCTIDÆ** Osborn.

Limnotheridæ Marsh.

The type genus, *Limnotherium*, is apparently preoccupied by *Notharctus* Leidy; if not, *Limnotheridæ* takes precedence.

Definition.—Upper incisors early reduced to $\frac{2}{2}$. Premolars persistent, but with reduced fangs. Molars relatively low crowned and low cusped; lower molars especially like those of many true Monkeys in the broad depressed and early crenulate or tuberculate talonid. Paraconid gradually reduced. External cusps of upper molars more crescentic than in *Hyopsodus* or *Adapis*, consequently developing a meso-style; also showing external cingulum.

Unlike the Hyopsodontidæ these animals show a progressive increase in size in ascending levels. This phylum certainly includes the numerous Wasatch and Wind River species referred to *Pelycodus* by Cope, the Bridger species referred to *Notharctus* and *Hipposyus* by Leidy; to *Hyopsodus* (in part), *Limnotherium*, *Thinolestes*, and *Telmatolestes* by Marsh; to *Prototomus* and *Tomitherium* by Cope. The species *Sinopa* (*Prosinopa*) *eximia* Leidy was based upon a jaw containing p_3, p_4, which should be compared with *Notharctus*.

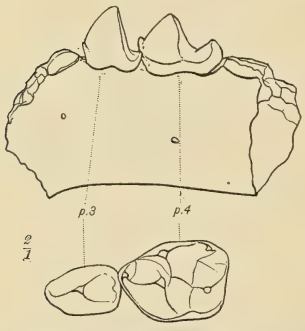


Fig. 18. *Sinopa* (*Prosinopa*) *eximia*. Type. Phila. Acad. Twice natural size.

To be compared with this family are the small animals, *Omomys carteri*, Leidy (?i. $\frac{2}{2}$, c. $\frac{1}{1}$, p. $\frac{3}{3}$); and *Hemiacodon gracilis* Marsh ($\frac{2}{2}$, $\frac{1}{1}$, $\frac{3}{3}$, $\frac{3}{3}$.), true molars = 11 mm., molars and premolars = 17.2 mm. Also *H. nanus* Marsh, *H. pucillus* Marsh; the two species last named, however, should also be compared with *Anaptomorphus*.

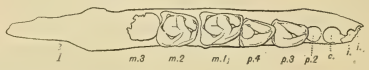


Fig. 19. *Omomys carteri*. Type. Superior view of right ramus, traced from a photograph. Twice natural size.

Chronological List.

Species of Pelycodus.

(35) *Pelycodus* (*Prototomus*) *jarrovii* Cope.....Wasatch
(38) " (*Tomitherium*) *frugivorus* Cope..... "
(43) " *tutus* Cope..... "
(45) " *nunienus* Cope.....Wind River

Species of Notharctus and Allied Types.

(4) *Notharctus tenebrosus* Leidy.....Bridger
(6) " (*Limnotherium*) *tyrannus* Marsh..... "
(7) " " *elegans* Marsh..... "
(10) " (*Hipposyus*) *formosus* Leidy..... "
(12) " " *robustior* Leidy..... "
(13) " (*Thinolestes*) *anceps* Marsh..... "
(14) " (*Telmatolestes*) *crassus* Marsh..... "
(15) " (*Limnotherium*) *affinis* Marsh..... "
(27) " (*Tomitherium*) *rostratus* Cope..... "

Pelycodus.

Jaw elongate. Mandibular symphysis uncoössified. Superior molars triangular with rudimentary hypocone; no mesostyle.

Notharctus.

Jaw stout. Symphysis typically coössified. Superior molars quadrate, with pronounced hypocone; a mesostyle.

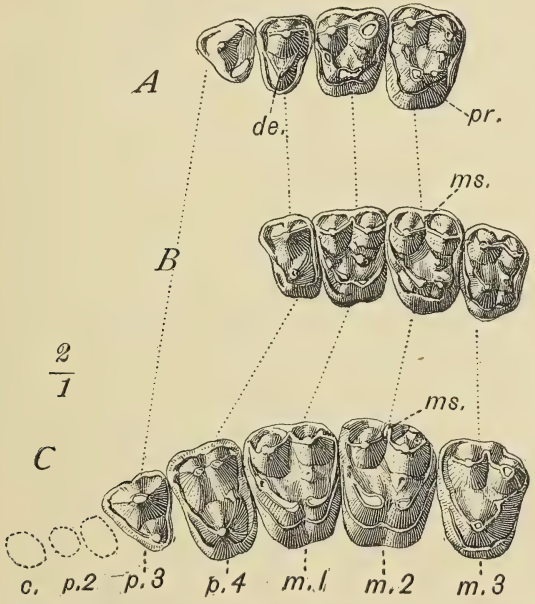


Fig. 20. Evolution of molars in Notharctidæ. *A*, *Pelycodus frugivorus*, Wasatch; *B*, *Notharctus nunienus*, Wasatch; *C*, *Notharctus* sp. indet. Bridger.

Genus PELYCODUS Cope.

Pelycodus is distinguished generically from the later members of the family by the more tritubercular upper molars, which exhibit the hypocone in all stages of development (Fig. 20) and the quinquetubercular lower molars which correspondingly show the paraconid in various stages of degeneration (Fig. 22). *P. frugivorus* is more tritubercular; *P. tutus* is more sexitubercular; a constant distinction from the contemporary *Hyopsodus* in the upper molars is the presence of an internal cingulum in *Pelycodus* which is wanting in *Hyopsodus*. In the Wind River specimens we also note the rise of the external intermediate column or mesostyle in a manner precisely analogous (homoplastic) to its development in the equine Perissodactyla. In other words the Lower Eocene *Pelycodus* is in a lower stage of evolution from the tritubercular (tuberculo-sectorial) type than its successors in the Middle Eocene (or Bridger) stage (Fig. 20).

Dentition.—In examining the rich Cope collection, now in the American Museum, the incisors are apparently $\frac{2}{2}$; the upper pairs are conical and not spaced; the canines are slightly enlarged and erect; the dental series is somewhat spaced, that is, the first and second premolars are not crowded (Fig. 21). The *lower molars* show traces of a hypoconulid; the first premolar is usually single fanged, and exceptionally bifanged; the crowns of pms 1–2 are simple. The third and fourth upper premolars show a single external cusp (protocone) and an internal cusp (deuterocone) while the fourth lower premolar is also slowly transforming into the molar pattern by the addition of a tritoconid. The *upper molars* may be clearly distinguished from those of the *Microsyops* line by the stronger development of the intermediate tubercles or conules (Fig. 20), which are exceptionally progressive, also by the more rounded or quadrate contour.

In the following descriptions dependence is placed largely upon the specific determinations made by Cope himself. The species undoubtedly require careful reëxamination.

Skeleton.—In the Wasatch species the jaw (*P. tutus*) is

stout but not very deep with a well rounded border and an uncoössified symphysis; the jaw increases in depth in the Wind River species (*P. nunienus*, Fig. 22). Many portions of the skeleton have been described by Cope, including metacarpals and digits, also a clawed terminal phalanx (as in the second digit of the lemuroid pes); unfortunately we must consider this association as somewhat doubtful. The femur (*P. tutus*) has a pit for the ligamentum teres and a long crest below the great trochanter. The radius has an oval head. The scapula has a prominent coracoid process. The head of the astragalus (*P. jarrovii*, Coll. U. S. Nat. Mus.) is convex and prolonged beyond the calcaneum. The caudals are long and slender.

1. Wasatch (Sparnacien, Yprésien) Stage.

Common Characters.—Superior molars more or less triangular, with rudimentary hypocone, without mesostyle.

(Sp. 35) **Pelycodus jarrovii** *Cope.*— This, the first species described, is represented by a rather imperfect type in the National Museum.

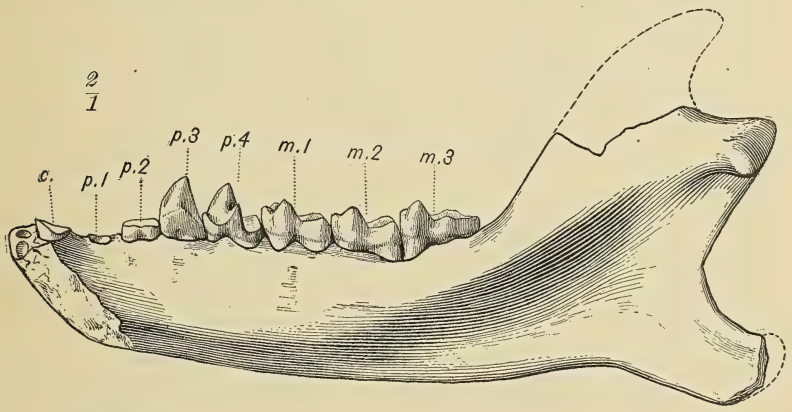


Fig. 21. *Pelycodus frugivorus.* Am. Mus. No. 65. Slightly less than 2 diam.

(Sp. 38) **Pelycodus frugivorus** *Cope.*— Includes the smaller and more primitive Wasatch specimens in which there is a variable rudiment of the hypocone in the upper molars (see

especially Nos. 55, 65, 4174, 4182, Amer. Mus.); the upper molars are strictly tritubercular, with little or no indication of a mesostyle. This is certainly a very primitive species and it probably comes from the lower levels of the Wasatch beds. Inf. ms = 15.5.

(Sp. 43) **Pelycodus tutus** *Cope.*— This, on the contrary, is the largest (inf. m. series=17.5 mm.), most progressive, and most abundant species. The superior molars are triangular in form but show a well developed hypocone forming a double internal lobe, but no mesostyle (see No. 4162, Am. Mus.). The paraconid, which is always the first primitive element to disappear among the Primates, shows every stage of position and development; it sometimes appears on $m_1 - m_3$, but is always distinct on m_1.

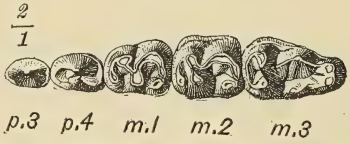


Fig. 22. *Pelycodus nunienus.* Type. Am. Mus. Cope, No. 4734.

Genus NOTHARCTUS Leidy.

2. Wind River (Lutétien) Stage.

As we might expect, in the Wind River specimens the first lower premolar is always single fanged, while in the superior molars the hypocone is decidedly more prominent so that in some cases they might be described as quadrate and sexicuspidate; a very conspicuous difference is the presence of the mesostyle (Fig. 20). The Wind River species are also generally distinguished by the more advanced transformation of the posterior premolars. As observed by Matthew, the Wind River species show closer affinities to those of the Bridger. In fact the Wind River specimens may well be referred to the Bridger genus *Notharctus* as characterized below. Cope was entirely mistaken in identifying the progressive Wind River species with the older Wasatch species (*P. jarrovii* and *P. tutus*).

(Sp. 45) **Notharctus nunienus** *Cope.*— Includes the smaller Wind River forms (m_1–m_3 = 15 mm.). We find a strong deuterocone (internal cusp) on pm_4.

(Sp. 58) **Notharctus venticolus,** Sp. nov.

A much larger monkey (No. 4715*b*, Am. Mus.) was referred by Cope to *P. tutus* but is clearly distinguished from this older Wasatch species by the presence of a mesostyle in the upper molars, and by the more progressive character of the grinding teeth throughout m — m_3 = 17. The type (No. 4715 *b*) was figured by Cope, 'Tertiary Vertebrata,' Pl. xxv, figs. 1, 2. Other specimens are No. 4726 (*op. cit.* fig. 3), Nos. 4728, 4738.

3. Bridger (Bartonien) Stage.

The gradual steps toward sexituberculy in the upper molars and quadrituberculy in the lower, begun in *Pelycodus*, lead directly into a number of Middle Eocene (Bridger) forms, mostly of larger size and on a higher plane of general development, baptized by Leidy, Cope, and Marsh with an unusual number and variety of names, as shown in the chronological table of species above. The identification of all these genera, however, needs confirmation by further comparison of types.

Unfortunately we have an incomplete record of the levels at which the types of these species and genera were found, but it is important to remember that the Bridger was a very long period, with time for the marked progression in dental structure observed in various specimens which may provisionally be referred to the single genus *Notharctus*. While there was considerable range of progression from the lower to the higher forms we cannot at present specify any single generic character which will enable us to clearly subdivide the Bridger species into different genera, because the progression although on a higher scale, is precisely analogous to that observed in the transition from *Pelycodus frugivorus* to *P. tutus*.

Notharctus has the same dental formula as *Pelycodus* but is readily distinguished by the coössified mandibular symphysis, the chisel-shaped incisors, the usually single fang of the first and sometimes of the second lower premolar, the comparatively well developed hypocone and the subquadrate shape of the upper molars; the usually marked reduction or absence of the paraconid in the lower molars.

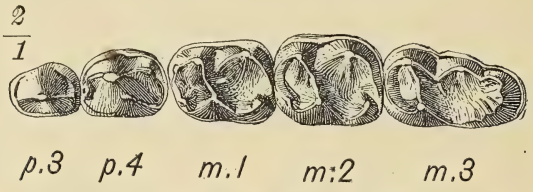


Fig. 23. *Notharctus* sp. indet. Princeton Mus. No. 10,020.

Thanks to the excellent type selected by Leidy, *N. tenebrosus*, to the beautiful specimen of *T. rostratum* (Am. Mus. No. 5009), and to the very complete series belonging to the Yale Museum, this genus is by far the best represented of all the American Primates, or in fact of any sub-Pliocene form excepting possibly *Adapis*. It is most interesting to observe the exact homoplasy between the variations in the cheek teeth with those seen in the early Ungulates.

(Sp. 4) **N. tenebrosus** *Leidy.*— The type (Phila. Acad.) is a relatively primitive species in which the second premolar is still bifanged, and there are traces of the paraconid on all the true molars; the third lower molar has a well developed heel or hypoconulid, the fourth premolar is sub-molariform. On the other hand its progressive specialization is marked by the low uniform wearing surface of the molars, the primitive trigonid being almost as depressed as the talonid; also by the large erect canine (probably indicating a male individual), by the well defined chin, by the unbroken dental series, and by the elevated condyle.

First Stage? Lower Bridger.

A stage beyond *N. tenebrosus* is the species or variety

(Sp. 13) **N. (Thinolestes) anceps** *Marsh*, in the type of which the second lower premolar is bifanged but the paraconid has disappeared upon the second and third molars, which are now truly quadritubercular. The mandibular dentition is otherwise closely similar to that of *N. tenebrosus;* the lower jaws are coössified, with the suture visible externally. In the upper molars of this important specimen we find the crown subtriangular, the primitive triangle with distinct intermediate tubercles, but the hypocone is prominent and well separated; there is also an external intermediate cusp or mesostyle; the first upper premolar is small or rudimentary. The third upper premolar has a broad internal cingulum, the fourth is submolariform.

Second Stage.

(Sp. 6) **N. (Limnotherium) tyrannus** *Marsh.*— (Type, Yale Mus.). The second specimen named in 1871 was also founded upon a lower jaw. Marsh described this as a "pachyderm" and distinguished the genus *Limnotherium* from *Notharctus* by the single fangs of the first and second lower premolars, by the quadritubercular lower molars "with a rudimentary double tubercle on the anterior margin" (paraconid). This type was probably found upon a somewhat higher level than *N. tenebrosus*. It marks perhaps the next higher stage of evolution in which the first and second premolars have single fangs; the paraconid is a vestigial tubercle seen on all three lower molars; the third upper molar is tritubercular. Close to this stage is the type of

(Sp. 27) **N. (Tomitherium) rostratum** *Cope*, with small, spaced, first and second lower premolars; in the latter the fang is still grooved.

Related to these are the more slender jaws forming the type of

(Sp. 15) **Limnotherium affine** *Marsh.* In this beautiful specimen, belonging to a young individual, we note a slight progression in the cheek teeth, the fourth upper premolar differs from the first molar only in the absence of the

hypocone, and sexituberculy is slightly more marked in the true molars than in *N. anceps;* the first and second lower premolars are single fanged, and, correlated with the development of the hypocone above, the paraconid has degenerated and disappeared upon the first and second molars below.

(Sp. 7) **N. (Limnotherium) elegans,** according to Marsh, is a much smaller but related species.

(Sp. 5) **N. (Hyopsodus) gracilis** *Marsh* exhibits a paraconid on the lower molars and thus either antedates *Notharctus (Limnotherium) elegans* or is possibly referable to *Sarcolemur.*

Third Stage.

It is evident from the study of the foregoing series that this line would inevitably terminate in sexituberculy above and quadrituberculy below. This condition is fulfilled in the type of

(Sp. 14) **N. (Telmatolestes) crassus** *Marsh*, a large species in which the first and second upper molars are nearly quadrate in form and bear six tubercles, the hypocone being almost as large as the protocone on m^1 and m^2; the hypocone however is wanting on m^3. The lower molars still retain a faintly developed paraconid. Near this stage is

(Sp. 10) **Hipposyus formosus** *Leidy*, founded upon a single upper molar (Leidy, '73, plate vi, fig. 41).

General Characteristics of the Teeth.— Notharctus was very abundant in the Bridger period and as seen in the above analysis presented progressive variations which are certainly due to the passage from lower to higher geological levels. The two pairs of incisors are compactly placed, with chisel-edges as contrasted with the rounded incisors of *Pelycodus;* the opposite pairs are spaced, that is there is a slight interval between them. The unworn *lower molars* are elongate (Fig. 23); they exhibit a transverse anterior crest (metalophid) between the protoconid and metaconid, in front of which is an oval valley bounded internally by the paraconid in all stages of degeneration; behind this ridge is the

posterior basin or talonid in which the enamel is waving or crenulate; the hypoconulid has disappeared excepting on the broad heel of m_3; the lower molars are thus very similar to those of monkeys and it is a complete surprise to find the *upper molars* with greatest diameter transverse and almost indistinguishable in pattern from those of the contemporary horses such as *Orohippus*. The protocone forms a low transverse crest with the protoconules (this is a rudimentary protoloph mechanically correlated with the metalophid below), while the hypocone and metaconule are isolated; the external cusps (paracone and metacone) are compressed with apical ridges running into an external intermediate mesostyle; the anterior cingule, or parastyle, is also developed. The fourth upper premolar is submolariform, with three large cusps (protocone, tritocone, deuterocone); it also exhibits traces of the conules (Fig. 20). The fourth lower premolar has an elevated protoconid connected by a low crest with a tritoconid and a deuteroconid.

This genus is finely represented in the American Museum by the skeleton and teeth, No. 1727; the upper molars are in a very progressive (*Telmatolestes*, *Hipposyus*) stage.

Family **ANAPTOMORPHIDÆ** Cope.

Definition.—Skull brachycephalic. Post-orbital process. Facial portion of lachrymal greater than orbital; fossa lacrymalis in front of crista. Premolars reduced, $\frac{2}{3-2}$. Grinding teeth arched, molars compressed antero-posteriorly, extended transversely, tritubercular, rudimentary hypocone. Short, deep, lower jaw. Lower molars with elevated trigonid region, reduced paraconid, no hypoconulid.

This family is represented by the type jaw of *A. œmulus* from the Bridger, the famous skull of *A. homunculus* from the Wasatch, together with portions of four isolated jaws; also possibly by a larger Upper Eocene species *Microsyops uintensis*.

Prior to Cope's description of the Bridger jaw are a number of specimens named by Marsh, as shown in the following chronological list, which possibly are related to this family or to the genus *Omomys*.

Chronological List of Species.

Sp. (21) ? *Hemiacodon gracilis* Marsh.....Bridger.
(22) ? " *nanus* " ..... "
(23) ? " *pucillus* " ..... "
(26) ? " (*Palæacodon*) *vagus* Marsh..... "
(28) ? *Anaptomorphus æmulus* Cope..... "
(39) ? *Pelycodus angulatus* Cope.....Wasatch (Indeterminate).
(47) *Anaptomorphus homunculus* Cope.....Wasatch.
(54) " (*Microsyops*) *uintensis* Osborn.....Uinta.

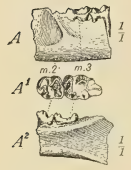


Fig. 23*a*. *Washakius insignis*. Type. Phila. Acad. External, superior, and internal views.

Fig. 24. *Anaptomorphus homunculus*. Type. Am. Mus. Cope. Skull, No. 4104; partly reconstructed from the two sides. Jaw from another specimen, Am. Mus. No. 43. Natural size.

Other animals to be considered in this connection are Leidy's *Washakius insignis*, Fig. 23*a*, '*Microsyops*' *speirianus* Cope, Fig. 37, and *Palæacodon vagus* Marsh.

It appears that Osborn was mistaken (Osborn and Wortman 1892, p. 102) in referring to this family the genus and species *Omomys carteri* Leidy.

Genus ANAPTOMORPHUS Cope.

Paraconid reduced, hypoconulid absent except on m_3, canines of medium size.

1. Wasatch (Sparnacien, Yprésien) Stage.

(Sp. 47) **Anaptomorphus homunculus** *Cope.—Type skull*, Amer. Mus. Cope Coll. No. 4194.

Definition.—i.$\frac{?}{?}$, c.$\frac{1}{1}$, p.$\frac{2}{3}$, m.$\frac{3}{3}$. M_1–m_3 with reduced paraconid, p_4 with very slight rudiment of deuterocone.

The species is represented by the famous type skull, also by specimens Nos. 41, 44. Paraconid on m_1 somewhat larger than in the Bridger *A. æmulus;* the deuteroconid is barely visible on p_4; there is a very small alveolus for the root of the second lower premolar.

The skull has been refigured with care (Fig. 24) to exhibit

its principal characters. In reference to Forsyth-Major's (1901) very precise examination of the lachrymal in the Lemuroidea and Anthropoidea it is important to note that this bone in *Anaptomorphus* resembles that in the Lemurs, especially such a form as *Opolemur* (*op. cit.*, p. 139, text fig. 37), much more closely than it does the lachrymal of *Adapis* or of any of the Anthropoidea, in the following respects: (1) the *pars facialis* is broader than the *pars orbitalis;* (2) the lachrymal fossa is extra-orbital, being bounded posteriorly by the *crista posterior lacrymalis* which forms the anterior rim of the orbit. In the words of Forsyth-Major: "In Lemurs, *as a rule* the *crista lacrymalis posterior* rides on the lower orbital margin, of which therefore it forms a portion . . . the anterior part of the lachrymal thus becoming the *pars facialis*, the posterior part the *pars orbitalis* . . . As a result, we have the lachrymal fossa outside the orbit. . . ." (*op. cit.* p. 134). *Anaptomorphus* resembles *Chrysothrix* in the reduplication of the infra-orbital foramen.

This sustains Cope's statement (1884, p. 250) and definitely proves that in the structure of its lachrymal *Anaptomorphus* is lemuroid; it does not, however, prove positively that it is a Lemur.

The transversely extended form of the upper molars and premolars is correlated with the brachycephaly of the skull; the molar pattern being best indicated in Fig. 25. Observe especially the depression and transversely oval form of the superior teeth, the relatively broad short crowns of the inferior teeth, the trigonid and talonid being of approximately the same width.

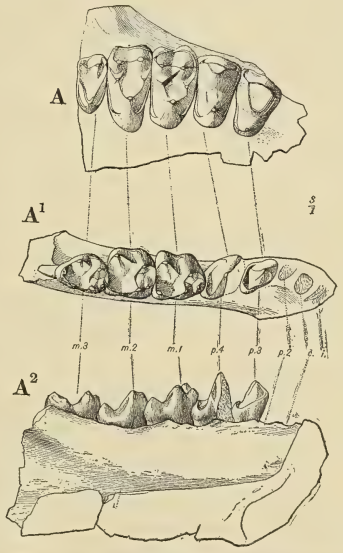


Fig. 25. *Anaptomorphus homunculus.* Am. Mus. No. 41. This specimen has unfortunately been misplaced.

The species *Pelycodus angulatus* Cope was based upon a type (Nat. Mus.), now unfortunately lost, containing a single lower molar which resembles that of *Anaptomorphus*, also that of *Cynodontomys*. In the absence of the type this species is indeterminate.

2. Bridger (Bartonien) Stage.

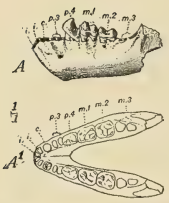


Fig. 26. *Anaptomorphus æmulus.* Type. Am. Mus. Cope, No. 5010. *A*, from side; A^1, reconstructed from above.

(Sp. 28) **Anaptomorphus æmulus** *Cope.*—*Type*, No. 5010, Amer. Mus. Cope Coll. This famous little jaw (Fig. 26) is the type of the genus. It exhibits progression on the Wasatch species in the loss of the second premolar, the formula being: I. $\frac{2}{3}$, C. $\frac{1}{1}$, P. $\frac{2}{2}$, M. $\frac{3}{3}$; paraconid especially on $m_{\frac{2}{2}}$ is also slightly more reduced, while the deuteroconid on $p_{\frac{4}{4}}$ is slightly more pronounced, but still not separate.

3. Uinta (Ligurien) Stage.

INCERTÆ SEDIS.

(Sp. 54) **? "Microsyops" uintensis** *Osborn.*—A reëxamination of the type of *Microsyops uintensis* (Amer. Mus. No. 1899) demonstrates that the reference of this type to *Microsyops* was an error, because the fourth lower premolar is totally unlike the molars. Its nearer reference is either to the Anaptomorphidæ or to some member of the Notharctidæ.

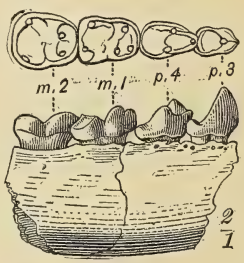


Fig. 27. "*Microsyops*" *uintensis.* Type. Am. Mus. No. 1899.

Part II. Rodentia.

Suborder **PROGLIRES,** subordo nov.

A primitive suborder of Rodents distinguished by the presence of rooted incisors, and canine teeth, and by the absence of any considerable diastemata and of antero-posterior motion of the jaw. Types: *Mixodectes*, *Olbodotes*, *Microsyops*.

It is obvious that these animals are far too primitive to be classed with the Protrogomorpha of Zittel which was framed to include all those modernized fossil and living rodents which do not naturally enter either of the four great divisions of Brandt.

Family **MIXODECTIDÆ** Cope.

Characters.—Median lower incisors close to symphysis, enlarged and elongating (unlike Tillodontia, in which second incisor is enlarged), lateral incisors early reduced; canines persistent (unlike Rodentia); no diastemata (unlike Rodentia), first and second premolars rapidly reduced; third premolar slowly reduced, fourth premolar progressively molariform (as in Tillodontia and Rodentia); lower molars with narrow, slightly elevated trigonid, but early reduced paraconid; talonid broad, hypoconulid small, except in third lower molar; superior molars tritubercular. A feature of the jaw is the sharp definition of a ridge descending from the coronoid and defining the masseteric insertion anteriorly (Fig. 3).

This phylum specialized very early.[1] The little animals which represent it are rare in the Torrejon and Wasatch, more abundant in the Wind River, and very common in the Bridger; not as yet reported in the Uinta. The specific forms range greatly in size but the essential progressive characters of the lower teeth are the same throughout this long geological period.

Ordinal position. — Cope placed *Mixodectes* among the Primates. Matthew ('97, p. 265) was the first to point out that the enlarged median tooth was probably an incisor and that the astragalus was exactly similar to that of a Rodent. He therefore took the important step of transferring this

[1] In 1892, Schlosser (Neues Jahrb. f. Min. Geol. u. Pal., Bd. II, s. 238) referred the contemporary Cernaysian Plesiadapidæ, *Plesiadapis* and *Protoadapis* Lemoine, to the Rodentia, removing them from the Insectivora.

genus to the Rodentia, leaving the position of the more recent members of the family undetermined.

Relationship to the Rodentia is now found to be indicated by: (1) progressive elongation of median incisor; (2) disappearance of lateral incisors; (3) reduction of canines; (4) disappearance of two anterior premolars and reduction of third premolar; (5) transformation of fourth premolar into molar form, thus foreshadowing a homodont molar-premolar series; (6) width and extension of talonid (as in Eocene *Paramys*); (7) rodent form of astragalus.

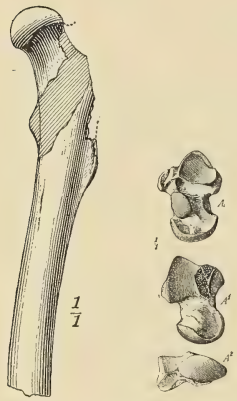


Fig. 28. *Mixodectes pungens.* Am. Mus. No. 2451. Left femur. Natural size. Astragalus, A, posterior; A^1, anterior; A^2, inferior or distal aspect. Natural size.

Against the Rodent relationship are: (1) Persistence of the canine; (2) absence of diastemata; (3) absence of any evidence (except the levelling of the premolars) of adaptation for antero-posterior or orthal motion of the jaw. Pending the final demonstration of this problem the Mixodectidæ may be placed in the new primitive suborder Proglires, defined above.

A careful reëxamination of all the material belonging to *Mixodectes*, *Cynodontomys*, and *Microsyops* has confirmed Matthew's observation that the enlarged median tooth is an incisor and has convinced us that these animals represent three successive stages in the same family.

A still more primitive stage is represented by a new genus to which the name *Olbodotes* (ολβοδότης) may be given, in reference to the happy solution it affords of the problem of the homology of the enlarged incisor teeth.

SYNOPSIS OF GENERA.

TORREJON.

Olbodotes.— $\frac{3}{3}$, $\frac{1}{1}$, $\frac{2}{2}$, $\frac{3}{3}$. One enlarged and two reduced incisors; two premolars, fourth premolar pointed; depressed paraconid on the molars.

Mixodectes.— $\frac{1}{1}$, $\frac{1}{1}$, $\frac{2}{2}$-$\frac{2}{1}$, $\frac{3}{3}$. One enlarged incisor tooth only; a canine, three to two premolars, fourth premolar pointed; depressed paraconid on the molars, a rudimentary hypoconulid.

WASATCH.

Cynodontomys.— $\frac{1}{1}$, $\frac{1}{1}$, $\frac{2}{2}$, $\frac{3}{3}$. One enlarged incisor only, two premolars, fourth premolar submolariform; a small paraconid and hypoconulid on the molars.

WIND RIVER AND BRIDGER.

Microsyops.— $\frac{1}{1}$, $\frac{1}{1}$, $\frac{2}{2}$, $\frac{3}{3}$. Greatly enlarged incisor; two premolars, third premolar further reduced, fourth premolar molariform; a small paraconid on the molars.

CHRONOLOGICAL LIST OF SPECIES. PARTLY INCERTÆ SEDIS.

Sp. (51)	*Mixodectes pungens* Cope	Torrejon.
(52)	" *crassiusculus* Cope	"
(8)	*Microsyops gracilis* Leidy	Bridger.
(9)	" (*Palæacodon*) *verus* Leidy	"
(18)	" (*Bathrodon*) *typus* Marsh	"
(19)	" (*Bathrodon*) *annectens* Marsh	"
(20)	" (*Mesacodon*) *speciosus* Marsh	"
(46)	" *scottianus* Cope	Wind River.
(49)	" (*Cynodontomys*) *latidens* Cope	Wasatch.
(59)	*Olbodotes copei* Osborn	Torrejon.
	Compare also *Indrodon malaris* Cope	"
	" " *Chriacus angulatus* Cope	Wasatch.

1. TORREJON (THANÉTIEN) BASAL EOCENE.

(Sp. 59) **Olbodotes copei,** gen. et spec. nov.

Type, No. 2385, Amer. Mus., left lower jaw.

Dentition.— $\frac{3}{3}$, $\frac{1}{1}$, $\frac{2}{2}$, $\frac{3}{3}$. An enlarged median incisor, two smaller incisors on the alveolar border behind it; canine small; third premolar reduced; fourth premolar high, simple, pointed, as in *Mixodectes*.

This specimen had previously been referred to *Mixodectes* but it differs in the retention of three incisor teeth and the loss of the second premolar tooth, which is represented by an alveolus in the type of *Mixodectes pungens*. There is little question about the presence of three incisors, the median one of which, although not preserved, has been much enlarged

so far as we can judge by its alveolus. The second and third incisors are equal sized with laterally compressed fangs (Fig.

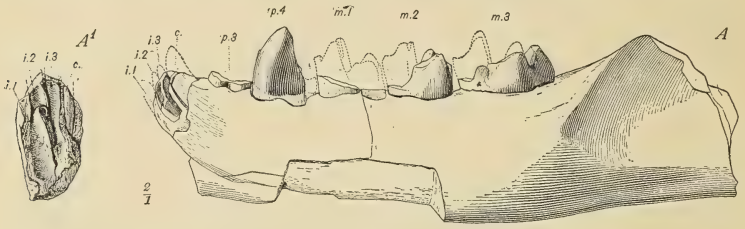


Fig. 29. *Olbodotes copei.* Type. Am. Mus. No. 2385. *A*, lateral view, A^1, anterior view, of left ramus.

29A¹). This further enables us to determine the single-fanged tooth at the edge of the jaw as a canine, an interpretation which is supported by the condition of this long single-fanged tooth, heretofore described as an anterior premolar, in *Cynodontomys* and *Microsyops*.

Fig. 29a. *Olbodotes copei.* Upper molar associated with type.

With the type of *Olbodotes* is associated an upper molar tooth (Fig. 29 a) resembling that of *Indrodon malaris* in the possession of a prominent mesostyle, and suggesting that *Indrodon* is probably a member of the Mixodectidæ. (See below.)

(Sp. 51) **Mixodectes pungens** *Cope.*— The well known type of this species (No. 3081 Amer. Mus.) shows no evidence

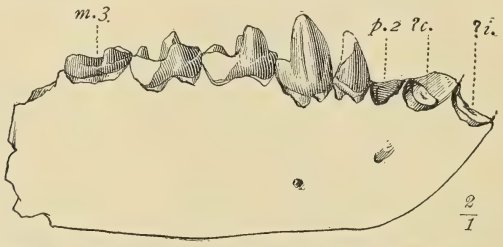


Fig. 30. *Mixodectes pungens.* Type. Am. Mus. Cope, No. 3081.

of the existence of the reduced lateral incisors seen in *Olbodotes* and is further distinguished by the variable presence of the second premolar.

Another specimen (No. 2557 *b*, Amer. Mus.) shows that the enlarged incisor is still a spatulate tooth with the enamel

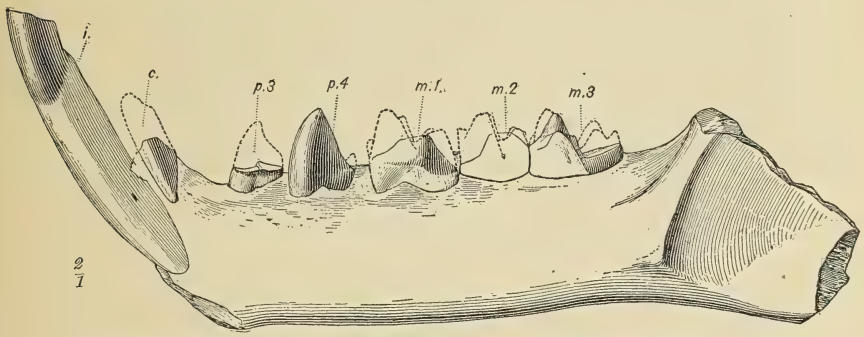


Fig. 31. *Mixodectes pungens.* Am. Mus. No. 2557*b*. Left lower jaw. Median incisor partly displaced.

completely surrounding the crown and a persistent fang (Fig. 31). Still another specimen (No. 3083 Amer. Mus.) gives a better view of the molar teeth.

(Sp. 52) **Mixodectes crassiusculus** *Cope.*— The type, No. 3087 Amer. Mus., consists of the posterior portion of the right and left rami of the lower jaws containing molar teeth. This specimen gives a perfect view of the structure of the molars, showing that they are even more specialized than those of *Cynodontomys* and *Microsyops* in the degeneration of the paraconid.

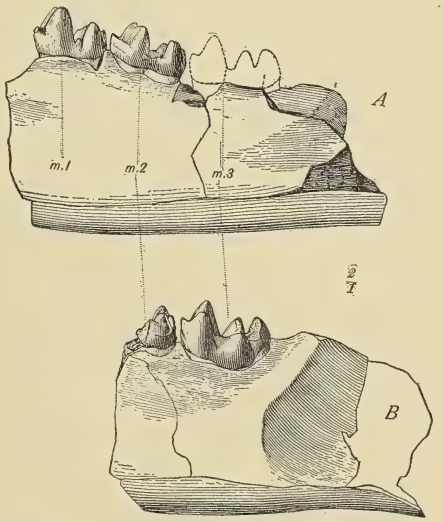


Fig. 32. *Mixodectes crassiusculus.* Am. Mus. Cope, No. 3087. Parts of right and left rami.

INCERTÆ SEDIS.

Genus INDRODON Cope.

As stated above (p. 170) this does not belong near the Anaptomorphidæ, the molar structure being entirely different. In previous articles, owing to the incorrect association of another specimen (No. 823), there has also been much confusion, which Matthew has partly cleared up (1897, p. 265).

Indrodon malaris *Cope.*— The type skull (Amer. Mus. No. 3080) is carefully redrawn in Fig. 33. Its conspicuous characteristics are: slightly enlarged median incisors, three premolars well spaced, fourth premolar with deuterocone; molars with broad external cingulum, crescentic para- and metacones and prominent mesostyle, rudimentary hypocone. The molar teeth resemble those of *Olbodotes*.

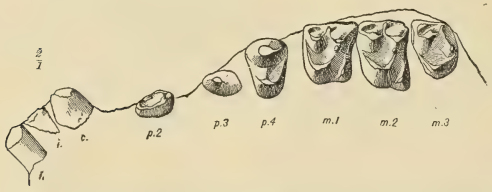


Fig. 33. *Indrodon malaris.* Type. Am. Mus. Cope, No. 3080. Left maxilla.

Specimen No. 833 also belongs to *Indrodon* but is more progressive than *I. malaris*, being distinguished by the breadth of the ectoloph and additional cusps on the fourth superior premolar.

Specimen No. 823 (Figs. 1, 2) was associated by Osborn and Earle (1895, p. 17) and believed to give us the skeletal characters of this animal; this association appears very questionable (see page 171).

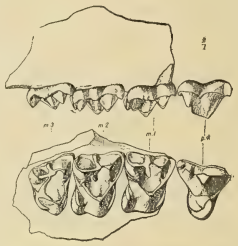


Fig. 34. *Indrodon* sp. Am. Mus. No. 833. Fourth premolar transposed from left side.

2. Wasatch (Sparnacien, Yprésien) Stage.

The genus *Cynodontomys* is only by courtesy and for want of better knowledge separated from *Microsyops*.

(Sp. 49) **Cynodontomys latidens** *Cope.* ? Syn. *M.* (*Chriacus*) *angulatus* Cope.—*Type:* the two rami of a lower jaw (Amer. Mus.

No. 4195), with molar teeth (ms.=11.5 mm.) in nearly parallel series; anterior pair apparently well developed and procumbent; lower premolars spaced, p_3 with paired fangs; p_4 a sub-quadritubercular tooth, namely with protoconid, tritoconid, deuteroconid, and tetartoconid; molars with narrow trigonid, paraconid small but distinct and median in position, broad talonid with a small hypoconulid. The ramus is long and rather slender, and the angle is produced posteriorly.

Cynodontomys is barely distinguished from its successors in the Wind River and Bridger by the less complete transformation of the fourth premolar and by the smaller single incisor. It is represented also by the juvenile jaw (No. 65), by the specimen (No. 4184) referred to *Chriacus angulatus* by Cope.

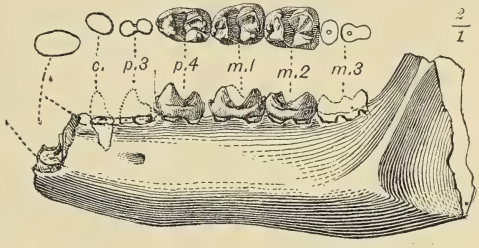


Fig. 35. *Cynodontomys latidens.* Type. Cope Coll. No. 4195 Wasatch. Big Horn Valley, Wyoming. Twice natural size.

Cope erroneously referred to this species a number of specimens from the Wasatch and Wind River horizons, with a short deep mandibular ramus, small heels upon the third lower molars, and general structure more similar to the Bridger series described below; ms. = 13.5 mm.

3. Wind River (Lutétien) Stage.

Genus MICROSYOPS Leidy.

Palæacodon Leidy, *Bathrodon* Marsh, *Mesacodon* Marsh.

(Sp. 46) **Microsyops scottianus** *Cope.—Type:* A long, shallow mandible (Amer. Mus. No. 4748), large semi-procumbent tooth with narrow diastema behind it; ms.=14 mm.; formula: $\frac{1}{1}, \frac{1}{1}, \frac{2}{2}, \frac{3}{3}$.

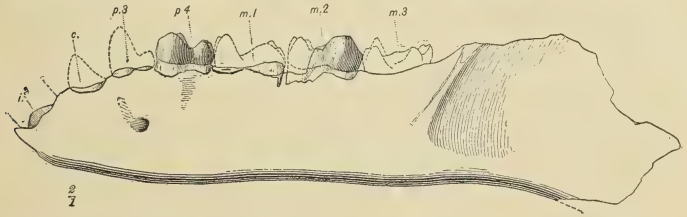


Fig. 36. *Microsyops scottianus.* Am. Mus. No. 4748. Slightly less than 2 diam.

The eight specimens from the Wind River formation (Amer. Mus. Nos. 4743–4748 inclusive), referred by Cope (Tertiary Vertebrata, p. 217) to *M. elegans* Marsh (or *M. gracilis* Leidy), represent a larger animal than *C. latidens* of the Wasatch; and agree closely with *M. scottianus* in size of the teeth, but certain of them differ in the greater depth of the mandible and coalescence of the fangs of p_3 (see No. 4743).

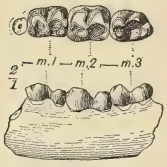


Fig. 37. "*Microsyops*" *speirianus*. Type. Am. Mus. Cope, No. 4190. Portion of right ramus.

(Sp. 44) **"Microsyops" speirianus** (Fig. 37). The type certainly does not belong to this genus. It resembles *Anaptomorphus* slightly.

4. Bridger (Bartonien) Stage.

(Sp. 8) **Microsyops gracilis.**— Leidy's type of the genus (*Microsyops gracilis* of the Bridger) was a small lower jaw in which he mistook the homologies and erroneously described six molars (ms. and pms.) and enlarged "canines," remarking that the number of incisors was indeterminate. Unlike those of the Anaptomorphidæ the lower molars are readily recognized by the narrow trigonid, now depressed to the level of the talonid, *i. e.*, more bunodont, depressed paraconid, behind which is the broad talonid bearing a hypoconulid; m_3 has a small cuspidate hypoconulid, unlike that in the Notharctidæ. So far as reported, upper molars have not been found associated, but it is probable that they are rightly identified in the broadly triangular (as distinguished from the more transversely oval form of the molars in the Anaptomorphidæ and the more quadrate form in the Hyopsodontidæ) tritubercular teeth, with a small cingule representing the hypocone, with intermediate spaces on the palatal side, as in all forms in which the trigonid is present; rudimentary conules and para-, meso-, and metastyles; the type of *Palæacodon verus* Leidy, described immediately after that of *Microsyops*, is such a tooth with small conules and a rudimentary hypocone (Leidy, '73, pl. vi, fig. 46).

It is probable that the types of *Palæacodon verus* Leidy, *Mesacodon speciosus* Marsh, *Bathrodon annectens* Marsh, also belong to this genus. The species *Palæacodon vagus* Marsh apparently belongs with the Anaptomorphidæ.

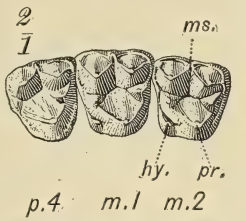


Fig. 38. *Microsyops.* Princ. Mus. Superior molars, isolated.

Leidy chose a rather uncharacteristic specimen [1] as the type and first adopted the specific name *M.* (*Hyopsodus*) *gracilis* Marsh; [2] but as the type of the latter species (*H. gracilis*) has four premolars it is probably related to *Notharctus* (*?Limnotherium*) *elegans*, as in fact suggested by Leidy himself (1873, p. 84). We are unable at present to straighten out the names of the Bridger formation species; they appear to be numerous.

Principal Characters of Microsyops.— $\frac{1}{1}$, $\frac{1}{1}$, $\frac{2}{2}$, $\frac{3}{3}$; median incisors very large, semi-procumbent, laterally compressed; p_4 submolariform; m_3 with small third lobe: symphysis not coössified.

The fourth premolar of *Microsyops* presents an advance upon that of *Cynodontomys* in the presence of a ridge uniting the two anterior cusps; the incisors were still larger and more procumbent, extending well back, below and inside of the fangs of the canines (Fig. 39). The external cingulum of the upper molars is not constant, sometimes faint; the valleys are smooth or slightly ridged. The upper molars (Fig. 38) are tritubercular, the primitive cusps (protocone, paracone, metacone), when unworn, being sharp and prominent; the conules faintly developed on m^1 and m^2; the hypocone is a

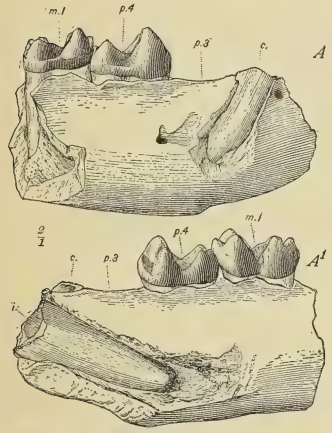


Fig. 39. *Microsyops.* Am. Mus. No. 1732. *A*, external, A^1, internal aspect of right ramus.

[1] Leidy '73 pl. vi, figs. 14, 17.

[2] Amer. Jour. Sci., July, 1871, p. 10.

mere cingule on the postero-internal slope of the protocone. The posterior heel (hypoconulid) of the lower molars is always very small, but sometimes forms a sharp narrow heel upon m_3; these teeth are further distinguished by the narrow primitive triangle; the paraconid is distinct on m_1, but decreases on m_2, m_3. The lower premolars are reduced.

(Sp. 20) **Microsyops** (**Mesacodon**) **speciosus** *Marsh.*—Type, a complete lower jaw (Yale Museum), lacking the incisive border and the articular portion. The measurements correspond with those of the other Bridger small species. The

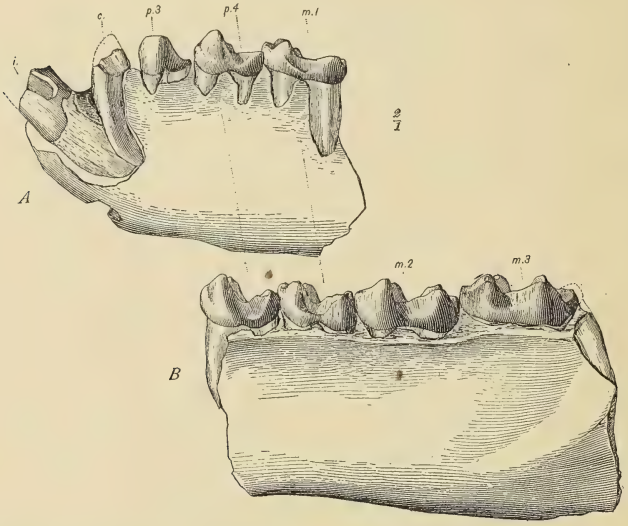


Fig. 40. *Microsyops? annectens.* Princ. Mus. Portions of rami of two individuals. Lower figure slightly exceeding 2 diam.

identification with *Microsyops* is due to the sub-molariform pattern of p_4. As observed by Marsh the anterior tooth is large, compressed, almost in contact with the symphysis; symphysis not coössified; lower border of jaw produced posteriorly angle slightly inflected; trigonid of lower molars very distinct.

(Sp. 18) **Microsyops** (**Bathrodon**) **typus** *Marsh.*— Type, a lower jaw (Yale Museum), containing the molar teeth (m_1–m_3=12 mm.) resembling that of *Microsyops* and *Mesacodon*,

coinciding in measurements and description, although the crucial tooth, p_4, is wanting.

(Sp. 19) **Microsyops (Bathrodon) annectens** *Marsh.*—Type, Yale Museum. This corresponds with the large specimens at the Princeton Museum (Fig. 40), but the paraconid is less elevated; the trigonid is narrow and the talonid broad, with three distinct cusps. The Princeton specimens have a deep jaw, with an unusually large procumbent incisor; the canine has a long single fang; p_2 is possibly represented by a rudimentary socket; the trigonid narrow and slightly elevated; the paraconid more or less distinct on m_1–m_3; hypoconulid faint on m_1, m_2, strong on m_3. The upper molars, which are provisionally associated with this species, bear a low, external, intermediate cusp or mesostyle, minute conules, and a low cingule representing a hypocone.

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Article XVIII. — LIST OF MAMMALS COLLECTED IN ALASKA BY THE ANDREW J. STONE EXPEDITION OF 1901.

By J. A. Allen.

The Andrew J. Stone Expedition was organized early in the year 1901, for the purpose, mainly, of securing mammals and birds from arctic and subarctic America, and incidentally from more southern points, as circumstances may favor, for the American Museum of Natural History. As at present planned, the work of the expedition will cover a period of three years, under the leadership of Mr. Stone, who has in previous years collected extensively for the American Museum in northern British Columbia, Alaska, and the Northwest Territory, under the patronage of the late James M. Constable, First Vice-President of the Museum. Mr. Constable made conditional provision for the further prosecution of the work, through an offer to contribute $2000 annually for three years contingent upon the raising of $3000 a year from other sources, making a total annual sum of $5000. The Museum is indebted to Miss Phebe A. Thorne for a further gift of $1000 a year for the period named, the remaining annual contingent of $2000 having been secured through the efforts of Mr. Madison Grant, Secretary of the New York Zoölogical Society, to whom the Museum is thus greatly indebted. The stipulated fund was completed in April, 1901.

Mr. Stone, with two assistants — Mr. J. D. Figgins of the Museum and Mr. Albert H. Mehner of Seattle,— left Seattle June 10, reaching Valdez, Alaska, June 19, and Homer June 21. After securing a boat and two native assistants, the party left Homer June 28, and proceeded to the head of Chugachik Bay, and thence up Sheep Creek, where a permanent camp was established, twenty miles above the mouth of the creek. On July 9 the wooded foothills were crossed and a temporary camp was made at the base of the Kenai

Mountains, where work was prosecuted till August 15, the highest altitude reached being about 4000 feet. Here a fine series of White Sheep was secured, as well as a Black Bear, a Wolverene, and many small mammals and birds. The party then returned to the permanent camp at the head of Sheep Creek, and later (August 21) returned to Homer, after many interruptions in their work from fog and storms.

On August 31 a second trip was made from Homer, back into the hills, undertaken especially to obtain Moose. For two weeks the search for these animals proved fruitless, but later several fine specimens were secured, and many small mammals and birds were obtained. The party returned to Homer on October 4, and preparations were immediately made for a trip to the western part of the Alaska Peninsula. Mr. Mehner returned to Seattle, and Mr. Stone and Mr. Figgins, after putting the collections in order for shipping, left on the little steamer 'Newport,' reaching Sand Point, Popof Island, October 19. The party was here storm-bound till October 26, when, with two helpers from Unga Island, the passage was made in open boats across Unga Strait to the mainland, a distance of about twelve miles. On October 30 nine head of Caribou were secured, and later, after much delay from stormy weather, others were obtained. The return to Sand Point, Popof Island, was made on November 10. The steamer for Kadiak did not arrive till December 5, and the enforced stay at Popof Island was utilized in securing large series of the small mammals and birds, and such other specimens as could be obtained. Owing to the lateness of the season the trip to the Alaska Peninsula, undertaken primarily for Caribou, which it was correctly supposed by Mr. Stone would prove new to science, was an undertaking of considerable peril and hardship, but it proved eminently successful. Besides the large series of the new Caribou, a large Bear, a Fox, a Seal, and a large number of small mammals and birds were secured. Owing to delay at Valdez for transportation southward, the party did not reach Seattle till January 2, 1902, after an absence of about seven months.

The collections obtained on this expedition prove of great

scientific interest and add a large amount of important material from a portion of North America previously almost unrepresented in our Museum collections. The large series of White Sheep from the Kenai Peninsula, the Caribou from the Alaska Peninsula, the Moose, Black and Grizzly Bears, the Shrews and Voles and other small mammals, and the birds, furnish excellent and much-needed material for exhibition and fill many important gaps in the study series. A few of the larger mammals were undescribed,[1] and many of the smaller ones have become known only within the last two or three years; they are still rare in collections and were previously wholly unrepresented in the Museum collection.

The present paper gives a list of the mammals obtained, numbering 26 species and 350 specimens, with field notes on the smaller species by Mr. Figgins. Only such species are mentioned as are represented by specimens. A list of the birds, by Mr. Chapman, follows the present article.

In September and October, 1900, Mr. Stone spent several weeks on Kenai Peninsula collecting large mammals for the Museum; mention of these specimens is included in the present report.

Two recent papers relating especially to the mammals of the Kenai Peninsula region are of interest in the present connection, namely: (1) 'Natural History of the Cook Inlet Region, Alaska.' By Wilfred H. Osgood, N. Am. Fauna, No. 2, Sept., 1901, pp. 51–81 (mammals, pp. 61–71, 35 species). (2) 'Notes on Mammals and Birds observed in southern Alaska in 1901.' By J. Alden Loring. Sixth Annual Report of the New York Zoölogical Society, April, 1902, pp. 145–154 (26 species).

I am indebted to Dr. C. Hart Merriam, Chief of the Biological Survey, Department of Agriculture, and to Mr. Gerritt S. Miller, Jr., of the United States National Museum, for their kindness in loaning me material for comparison in determining some of the more difficult species of the collection.

[1] The following papers, published in this Bulletin during the last few months, were based on the present collection: (1) A new Caribou from the Alaska Peninsula (*antea*, pp. 119–127, figs. 1–6, March 31, 1902); (2) A new Bear from the Alaska Peninsula (*antea*, pp. 141–143, pll. xxx and xxxi); (3) A new Sheep from the Kenai Peninsula (*antea*, pp. 145–148, figs. 1, 2).

1. **Lagenorhynchus obliquidens** *Gill.* Striped Dolphin.

Lagenorhynchus obliquidens Gill, Proc. Acad. Nat. Sci. Phila. 1865, 177. — True, Contr. Nat. Hist. Cetaceans, Bull. No. 36, U. S. Nat. Mus. 1889, 96, 172, pl. xxvii.

One specimen, a complete skeleton, Valdez, Alaska, June 19.

2. **Paralces gigas** (*Miller*). Alaska Moose.

Alces gigas Miller, Proc. Biol. Soc. Wash. XIII, 1899, 57, May 29, 1899. — Stone, Deer Family (by Roosevelt, Van Dyke, Elliot, and Stone), 1902, 291–325 (*passim*), and 4 half-tone plates.

Paralces gigas Allen, Bull. Am. Mus. Nat. Hist. XVI, 160, July 1, 1902.

On Mr. Stone's first visit to the Kenai Peninsula in September and October, 1900, he obtained three fine adult males of this species, two young males, and two young females. In September (Sept. 15 to 30), 1901, two more fine old males and two three-year-old males were secured, making altogether a series of 10 specimens. These are accompanied by full measurements, from which it appears that the adult males attain a length of about 9 feet (2743 mm.), and a height at the shoulders of 6½ feet (1981 mm.). Mr. Stone, in his recent article on the Moose of North America (Deer Family, *l. c.*, p. 300), gives the average spread of the antlers as 65 inches (1652 mm.), and the maximum of those he has seen as 74 inches (1870 mm.). Mr. Stone, in the paper above cited, gives much interesting information respecting the habits, distribution, and external characters of the Moose of North America as observed by him in Alaska, British Columbia, and the Northwest Territory.

3. **Rangifer stonei** *Allen.* Stone's Caribou.

Rangifer stonei Allen, Bull. Am. Mus. Nat. Hist. XIV, 143, figs. 1–4, May 28, 1901 (Kenai Peninsula); *ibid.* XVI, 126, March 31, 1902 (in text). — Osgood, N. Am. Fauna, No. 21, 61, Sept. 26, 1901. — Loring, Sixth Ann. Rep. N. Y. Zoöl. Soc. 145, April 1, 1902.

Caribou of the Kenai Peninsula, Alaska, Elliot, Publ. Field Col. Mus. Zoöl. Ser. III, No. 5, July, 1901.

This Caribou is nearly extinct on the Kenai Peninsula. Mr. Stone failed to obtain any specimens during his long stay on the Peninsula in 1901. He says: "I did not go into the Caribou hills on the Kenai Peninsula for the reason that there were more hunters in these hills than there were Caribou. A strong effort was made by Mr. Herbert's hunting party, for Caribou, without success." Mr. Loring reports the existence of Caribou in the mountains of the Shushitna River district, which he believes are referable to this species.

4. **Rangifer granti** *Allen.* Grant's Caribou.

Rangifer granti Allen, Bull. Am. Mus. Nat. Hist. XVI, 122, March 31, 1902.

There is nothing to add to the account of this species already given (*l. c.*, pp. 119–127, figs. 1–6).

5. **Ovis dalli kenaiensis** *Allen.* Kenai White Sheep.

Ovis dalli Osgood, N. Am. Fauna, No. 21, 62, Sept. 1901. — Loring, Sixth Ann. Rep. N. Y. Zoöl. Soc. April, 1902, 143, 146. Habits and decrease in numbers.

Ovis dalli kenaiensis Allen, Bull. Am. Mus. XVI, 145–148, figs. 1 and 2, April 23, 1902.

A series of 14 specimens was taken on Sheep Creek, Kenai Peninsula, July 10 to August 14, 1901. An account of them has been given in a previous paper (*l. c.*).

The range of *Ovis dalli kenaiensis* is quite disconnected from that of *Ovis dalli*, the two being separated by an extensive area not inhabited by either form.

6. **Sciurus hudsonicus** *Erxleben.* Hudson Bay Red Squirrel.

Sciurus hudsonicus Osgood, N. Am. Fauna, No. 21, 63, Sept. 1901. —Loring, Sixth Ann. Rep. N. Y. Zoöl. Soc. April, 1902, 148.

Nine specimens, July, August, and September. All are in post-breeding pelage and hence very different from winter specimens.

"Found throughout the timber belt, but nowhere abundant. Nests were seldom seen in trees, and they appear to spend

much of their time underground. They occupy one locality for a long time, as shown by the large piles of gnawed pine cones at the entrances to their underground passages. They seem to feed entirely on the buds and cones of the spruce."—J. D. F.

7. **Arctomys pruinosus** *Gmelin.* Hoary Marmot.

Arctomys caligatus Osgood, N. Am. Fauna, No. 21, 63, Sept. 1901.
Arctomys pruinosus Loring, Sixth Ann. Rep. N. Y. Zoöl. Soc. April, 1902, 148.

Two half-grown males, Kenai Mountains, July 16, and an additional skull.

"Contrary to our anticipations, we found the marmot very uncommon on the Kenai Peninsula. One pair with young was found on the barren ground between the forks of Sheep Creek, at an altitude of about 5200 feet. Their 'den' had no doubt been used for many years, as shown by the mound of earth they had thrown up, and the growth of vegetation that covered its sides. The height of the mound and the rankness of the vegetation growing upon it made it a conspicuous object, visible for nearly half a mile. When the 'den' was approached the marmots abandoned it, with cries of protest, and took refuge in the adjacent rock-slides, where trapping was nearly impossible. This family was at first not shy and could be easily approached, but after two of their number had been trapped they became very wary and were seldom seen though often heard. Another den was seen, but it was apparently not inhabited."—J. D. F.

8. **Evotomys dawsoni** *Merriam.* Dawson Red-backed Mouse.

Evotomys dawsoni Merriam, Am. Nat. XXII, 649, July, 1888. Finlayson River, N. W. T. — Osgood, N. Am. Fauna, No. 21, 64, Sept. 26, 1901.

? *Evotomys orca* Merriam, Proc. Wash. Acad. Sci. II, 24, March 14, 1900. Orca, Prince William Sound, Alaska.

Evotomys dawsoni orca Loring, N. Am. Fauna, No. 21, 64 (in text), Sept. 26, 1901.

The 35 specimens were collected as follows: Sheep Creek, 7 specimens, July 6 and August 17 and 18; Kenai Mountains, 16 specimens, July 13 to August 15; in the hills back of Homer, 12 specimens, August 21 to September 19. About two thirds of the specimens are adults and the rest in various stages of immaturity.

These specimens should be referable to *Evotomys dawsoni orca* rather than to true *dawsoni*. They seem, however, not to differ appreciably from specimens collected previously by Mr. Stone on Telegraph Creek, the Liard River country, and at Fort Norman. Mr. Osgood (*l. c.*) seems to have had difficulty in satisfactorily determining his large series from near Hope and Tyonek, localities somewhat to the northward of the Kenai Peninsula.

"This mouse was not common at any point visited, but was found throughout the timber belt from tidewater to its upper limit."—J. D. F.

9. **Microtus kadiacensis** *Merriam.* Kadiak Vole.

Microtus kadiacensis Merriam, Proc. Biol. Soc. Wash. XI, 222, July 15, 1897. Kadiak Island.
Microtus operarius kadiacensis Osgood, N. Am. Fauna, No. 21, 64, Sept. 26, 1901.

A single immature specimen (about half-grown) is provisionally referred to this species. It was taken in the hills back of Homer, Sept. 8.

10. **Microtus miurus** *Osgood.* Alaska Mountain Vole.

Microtus miurus Osgood, N. Am. Fauna, No. 21, Sept. 26, 1901, 64. Mountains, near Hope City, Turnagain Arm, Cook Inlet, Alaska.

Represented by 8 specimens, only one of which is adult, the others being from one fourth to one half grown. They were all taken in the Kenai Mountains, July 5, 20, and 22.

"Met with only in a small valley between ridges near the top of the Kenai Mountains at an altitude of about 5000 feet. The space occupied by this colony was an area about 200 feet long by about 40 feet in width. Old 'signs' of them were

abundant in the higher barren grounds. These signs consisted of burrows or holes in the ground, without, however, any indication that they were formed by excavation from above, as no earth was brought out to the surface. Neither do they appear to construct runways through the grass, as most other voles do. Apparently they spend but little time above ground except when feeding. Freshly cut sprays of lupine and grasses were always found just at the edge of the holes, as though placed there for a convenient food supply.

"These mice are cannibals of the most pronounced type, and for this reason very few perfect specimens could be obtained. They also proved very difficult to trap, although many kinds of bait were tried. As soon as a specimen was trapped it was immediately attacked and usually devoured or so mutilated as to be worthless for a specimen."—J. D. F.

11. **Microtus unalascensis popofensis** *Merriam.* Popof Island Vole.

Microtus unalascensis popofensis Merriam, Proc. Wash. Acad. Sci. II, 22, March 14, 1900. Popof Island, Alaska. — Bailey, N. Am. Fauna, No. 17, 42, June 6, 1900.

This species is represented by 72 specimens, all taken at Sand Point, Popof Island, the type locality, in October (Oct. 20–23) and November (Nov. 13–30), by Mr. J. D. Figgins. All are practically adult, as regards color and pelage, but the series includes many young adults, as shown by the skulls. The series includes 41 males and 31 females. There is a slight sexual difference in size, the males averaging slightly the larger, as follows: Total length, ♂ ♂ 165 (155–210), ♀ ♀ 159 (155–203); tail, ♂ ♂ 32 (25–51), ♀ ♀ 31 (25–38); hind foot, ♂ ♂ 22.2 (20.6–23.9), ♀ ♀ 22.3 (20.6–25). Size is obviously no criterion of sex. The above statistics include all the specimens of the series. The average is practically the same as that given by Mr. Bailey for a series of three topotypes, except as to the tail, where there is a discrepancy of 6 mm., due probably to different methods of measuring.

The following analysis of the above is of interest: Of the

72 specimens, 4 males and 12 females fall below 6 inches (152.4 mm.) in total length; 4 males and 7 females have a length of 7 inches (177.8 mm.) or more; and 33 males and 12 females measure 6 to 6.75 inches (152.4 to 171.5 mm.). The tail length in 9 males and 7 females falls below 1.25 in. (31.75 mm.), 5 males and 3 females have the tail length 1.50 in. (38.1 mm.) or more, and in 34 males and 13 females the tail length is 1.25 to 1.50 in. (31.75 to 38.1 mm). In 3 males and 6 females the length of the hind foot is less than .875 in. (22.2 mm.), in 4 males and 2 females it slightly exceeds this length, while in 34 males and 23 females, the length as recorded by the collector is 22.2 mm.

As usual in large series of small mammals a few specimens far exceed the average in size, being the giants of their race, while others, equally adult, fall greatly below the average. In the present series one female attains the length of 203 mm., and others range above 190, the average being about 160. One male reaches 210, and three others measure 197, against an average of 165.

The series as a whole is quite uniform in coloration, but extreme specimens are widely diverse, although all were taken late in autumn during a period of about five weeks. A few specimens represent a pale or gray phase, in which the usual strong yellowish brown suffusion of the upper parts is greatly reduced, while in still other specimens it is greatly emphasized and darkened, so as to border on rufous with a stronger admixture of black-tipped hairs. The two extremes in coloration — the gray and the deep ruddy fulvous — might readily suggest specific differences, were it not that they are fully connected by intermediate stages.

The ventral surface varies from clear whitish gray to a strong suffusion of buff; in average specimens the ventral surface is tinged with pale buff.

"Popof Island was literally overrun with these mice. Since the extermination of the foxes here there appears to be no check upon their increase, and they have become a nuisance. Their habits greatly resemble those of the common meadow mouse of the East. They construct roadways by tunnelling

under the moss and muskeg where the vegetation is not sufficient to conceal them. In excavating their underground passages the dirt is brought to the surface. They appear to work almost constantly, as fresh dirt was noticed daily.

"At Sand Point an attempt at gardening proved a failure through their depredations, as they attacked the plants and destroyed everything. Mr. Libby of Unga Island assured me that he removed forty-five pounds of potatoes from one of their underground storehouses which they had pilfered from a nearby warehouse. The potatoes that were too large to be taken through their runways had been gnawed to reduce them to the proper size for transportation.

"These mice seldom took the bait from the traps but were readily taken by placing the traps in their runways. When traps were placed at the entrance to their underground runways the mice always covered the traps with moss, grass, and dirt. They are both nocturnal and diurnal in their habits. I found visits to the traps at night and morning yielded about equal catches."— J. D. F.

13. **Erethizon epizanthus myops** *Merriam.* ALASKA PORCUPINE.

Erethizon epizanthus myops MERRIAM, Proc. Wash. Acad. Sci. II, 27, March 14, 1900.— OSGOOD, N. Am. Fauna, No. 21, 66, Sept. 1900.— LORING, Sixth Ann. Rep. N. Y. Zoöl. Soc. April, 1902, 149.

One specimen, adult male, skin and skull, Alaska Peninsula, opposite Popof Island, Nov. 4; two skulls, Sheep Creek, August.

"Three or four of these animals were observed on the Alaska Peninsula during our short stay there, but only one was obtained. They are said to be abundant there. One was seen, possibly migrating, at an altitude of at least 2500 feet, on a bleak and barren peak, where the only vegetation was lichens. Its favorite haunt is the low ground near the coast, where the alder is abundant, and the overhanging banks of small streams afford safe retreats.

"They were also common on the south side of Kachimalo

Bay, Kenai Peninsula, especially along the small glacial streams, where spruce and cottonwood were abundant."— J. D. F.

14. **Lepus americanus dalli** *Merriam.* Dall Varying Hare.

Lepus americanus dalli Merriam, Proc. Wash. Acad. Sci. II, 29, March 14, 1900. — Osgood, N. Am. Fauna, No. 21, 67, Sept. 1901.

Two specimens, an adult male and a half grown young, Sheep Creek, July 6.

"These were the only specimens seen, and the natives represented it as uncommon."— J. D. F.

15. **Phoca richardsi** (*Gray*). Harbor Seal.

Halicyon richardsi (*richardii* in error) Gray, P. Z. S. 1864, 28.

A skin of a young specimen, taken on the Alaska Peninsula, opposite Popof Island, Nov. 7.

16. **Vulpes alascensis** *Merriam.* Alaska Red Fox.

Vulpes alascensis Merriam, Proc. Wash. Acad. Sci. II, 668, Dec. 28, 1900.

One specimen, an adult female, Alaska Peninsula (opposite Popof Island), Oct. 31. Length, 1117 mm.; tail, 433; hind foot, 178. (For skull measurements see table under *V. kenaiensis*.)

This specimen agrees very well with Dr. Merriam's description of *V. alascensis*, except that the neck and shoulders are deep rufous rather than "golden fulvus."

The skull is apparently as large as that of *V. kenaiensis* (see table of measurements, p. 226), the skull (female) from the western end of the Alaska Peninsula nearly equalling in general dimensions those given for the male skull of *kenaiensis*, but the teeth, especially the upper carnasial and first molar, are very much smaller.

"Many fox tracks were seen along the beach of the Alaska Peninsula, and also trails in the grass ran from the streams in every direction. The first snow gave evidence that these trails were in use. The specimen taken was killed while feeding on a caribou carcass. The natives take hundreds of Red

Fox skins to Sand Point each year, which they catch on the Alaska Peninsula."— J. D. F.

17. **Vulpes kenaiensis** *Merriam.* Kenai Fox.

Vulpes kenaiensis Merriam, Proc. Wash. Acad. Sci. II, 670, pl. xxxvi, fig. 5, Dec. 28, 1900. — Osgood, N. Am. Fauna, No. 21, 68, Sept. 1901.

This species was described from a single male skull, the "skin not seen," and hence "external characters unknown"; "pelage said to be softer and more valuable than the neighboring (*harrimani*), which has very coarse fur." It is said to differ from *V. harrimani* in being larger, with longer rostrum and larger teeth, etc.

The present collection contains two skulls from the Kenai Peninsula, but no skins. The skulls are fully adult, but not 'old'; they differ a little in size and probably represent both sexes. The largest one, however, falls decidedly below the measurements given by Dr. Merriam for the type, as shown by the subjoined table.

Measurements of Skulls of *Vulpes kenaiensis.*

		Basal length.	Basilar length.	Palatal length.	Postpalatal length.	Zygom. breadth.	Interorbital breadth.	Breadth of rostrum.	Length of pm¹.	Length of m¹.
Type.[1]	♂ ad.	148	145	79	68.5	82.5	30.5	27	15.5	11
18064	ad.	138	129	70	60	74	27	23	15	10
18065	ad.	136.5	127	69	58.5	—	27	23	14	10
17946[2]	♀ ad.	144	136	76	61	78	31	26	14	10

"The only fox seen on Kenai Peninsula was a light gray specimen observed on the Kenai Mountains at an altitude of about 5000 feet. Fox signs were noted in the timber belt and on the bare hills to the west of Kachimalo Bay, where there were well-defined paths in the high grass at the top of the first bluff from the bay. One deserted den was found." — J. D. F.

[1] Measurements as given by Dr. Merriam, *l. c.*

[2] A very old female of *V. alascensis*, from western end of Alaska Peninsula, for comparison.

18. **Ursus merriami** *Allen.* Big Alaska Bear.

Ursus merriami Allen, Bull. Am. Mus. Nat. Hist. XVI, 141, pll. xxx, xxxi (skull), April 12, 1902.

? *Ursus dalli gyas* Merriam, Proc. Biol. Soc. Wash. XV, 78, March 22, 1902.

There is nothing to add to the account already given (*l. c.*) of the two specimens of this bear obtained by Mr. Stone at the western end of the Alaska Peninsula, except to say that the type skull of *U. merriami* has since been compared with those on which Dr. Merriam based his *U. dalli gyas*. The type of *U. merriami* is unlike any of the latter, which are nearly all very old males, while the type of *U. merriami* is a rather young skull and probably a female. As *gyas* and *merriami* have been found at practically the same locality, and it being hardly probable that two distinct species of large bears occur together on this part of the Alaska Peninsula, it seems probable that additional material will show that *gyas* and *merriami* are the same, and that *gyas*, which has three weeks' priority over *merriami*, is the name that will have to be adopted for this large bear.

19. **Ursus horribilis alascensis** *Merriam.* Alaska Grizzly.

Ursus horribilis alascensis Merriam, Proc. Biol. Soc. Wash. X, 74 (in text), April 13, 1896.— Osgood, N. Am. Fauna, No. 19, Oct. 1900, 41.

Ursus horribilis Loring, Sixth Ann. Rep. N. Y. Zoöl. Soc. April, 1902, 151.

Five specimens, all females, from the mountains south of Homer, all adults except one. Three were obtained in September, 1900, and the others in 1901.

20. **Ursus americanus** *Pallas.* Black Bear.

Ursus americanus Osgood, N. Am. Fauna, No. 21, 68, Sept. 1901.— Loring, Sixth Ann. Rep. N. Y. Zoöl. Soc. April, 1902, 150.

Five skins with skulls, and 8 additional skulls, all from Kenai Peninsula; 6 were collected in September, 1900, and 7 during the season of 1901.

21. **Putorius arcticus kadiacensis** *Merriam.* TUNDRA WEASEL.

Putorius arcticus kadiacensis MERRIAM, N. Am. Fauna, No. 11, 10, 16 (in text), June, 1896.
Putorius kadiacensis OSGOOD, N. Am. Fauna, No. 21, 69, Sept. 1901.

One specimen, an adult female, taken at Homer, June 22.

"Said to be common at Homer in the winter. One specimen was taken and two others were seen; no others were seen though every effort was made to secure additional specimens." — J. D. F.

22. **Mustela americana actuosa** *Osgood.* ALASKA MARTIN.

Mustela americana actuosa OSGOOD, N. Am. Fauna, No. 19, 43, pl. vii, fig. 2, Oct. 6, 1900.

A single skull from Kenai Peninsula (sex unknown) is provisionally referred to this subspecies, on account of its large size. It is much too large for *M. americana*, and though smaller than the male type of *actuosa*, may well be a female of that species.

23. **Gulo luscus** (*Linn.*). WOLVERENE.

One specimen, an adult male, Sheep Creek, July 27.

"Only one specimen was taken and one other seen. They were feeding on the carcass of a sheep."— J. D. F.

24. **Sorex obscurus shumaginensis** (*Merriam*). SHUMAGIN ISLANDS SHREW.

Sorex alascensis shumaginensis MERRIAM, Proc. Wash. Acad. Sci. II, 18, March 14, 1900. Popof Island, Shumagin Islands, Alaska.

This shrew is represented by 57 specimens of which 52 were taken at Sand Point, Popof Island, Oct. 20–22 and Nov. 13–22, and 5 on the neighboring coast of the Alaska Peninsula, Nov. 1. The series contains considerably more females than males. About 10 are in the short brown pelage of summer, and 22 in the full long gray pelage of winter; the remaining 25 are in

mixed pelage of varying stages of change, from brown specimens in which the gray is coming in at the posterior end of the body to gray specimens in which the front of the head and sides of the neck and shoulders are the only parts still brown. They all appear to be practically adult as regards general size and pelage, but the skulls show that many are merely young adults. There is no very evident sexual difference in size. Twelve males and 16 females, taken at random, give the following measurements: Total length, males, 113 mm. (107–121), females, 114.5 (108–121); tail, males, 46 (44–50), females, 45 (43–48); hind foot, 13 (13–14) in both sexes.

Specimens in the brown pelage are much paler throughout than topotypes of *alascensis* (taken in July) in corresponding pelage. *S. shumaginensis* is also decidedly smaller than *alascensis*.

"On Popof Island, and on the adjoining part of the Alaska Peninsula, where timber is absent, shrews are extremely abundant."— J. D. F.

25. **Sorex obscurus alascensis** *Merriam.*

Sorex obscurus alascensis MERRIAM, N. Am. Fauna, No. 10, 76, Dec. 1895. Yakutat Bay.

Sorex alascensis shumaginensis OSGOOD, N. Am. Fauna, No. 21, 71, Sept. 1901. Hope and Tyonek, Kenai Peninsula.

This abundant species, represented by 73 specimens, was obtained at all points on the Kenai Peninsula where any collecting was done. Late in September it begins to pass into a gray winter pelage, as shown by specimens taken in the Kenai Mountains Sept. 19 and 26, one of which is almost entirely gray, while the other has a gray body and a brown head. The gray seems to be a darker shade than in the specimens of *S. o. shumaginensis* in corresponding pelage. In summer pelage the Kenai specimens are decidedly paler than topotypes of *alascensis* from Yakutat Bay.

Forty specimens, taken at random, and including about an equal number of males and females, measure as follows: Total length, 113 (107–121); tail, 47.7 (44.5–50.8); hind foot, 13 (12.7–14).

26. **Sorex personatus streatori** *Merriam.*

Sorex personatus streatori MERRIAM, N. Am. Fauna, No. 10, 62, Dec. 1895. Yakutat Bay.

Sorex personatus OSGOOD, N. Am. Fauna, No. 21, 70, Sept. 1901. Hope and Tyonek, Kenai Peninsula.

Apparently much less abundant than the preceding species, but occurs with it at all of the localities where collections were made. The 30 specimens were collected as follows: Kenai Mountains, August 2–9; Sheep Creek, August 17, 18; hills near Homer, Sept. 6–26.

Sixteen specimens measure as follows: Total length, 92 mm. (82.5–98); tail, 38 (35–43.7); hind foot, 11.

Speaking collectively of these two shrews, Mr. Figgins observes:

"Shrews were the most abundant of all the mammals at all the points visited on Kenai Peninsula. They were confined almost entirely to the timber belts and alder and willow patches between timber line and the barren grounds. One specimen, taken at an altitude of about 2000 feet, was the only exception."— J. D. F.

Article XIX.—LIST OF BIRDS COLLECTED IN ALASKA BY THE ANDREW J. STONE EXPEDITION OF 1901.

By Frank M. Chapman.

The conditions under which the Stone Expedition of 1901 was made, and the localities at which specimens were secured, are fully described in the preceding paper[1] by Dr. Allen. Undertaken primarily to secure examples of the larger mammalia, birds were considered of secondary importance, the use of firearms in obtaining them being prohibited whenever it was supposed big game was in the vicinity. The collection contains, therefore, only 302 specimens, representing 68 species and subspecies, constituting, however, an exceedingly desirable addition to our Museum collection which had previously contained practically no specimens from the region in question. The collection was made chiefly by Mr. J. D. Figgins, Mr. Stone's assistant, at the following localities: Homer, June 21–28, and August 21–31; Sheep Creek and Kenai Mts., July 1–August 15; Sand Point, Popof Island, October 19–26, and November 10–December 5. Mr. Figgins's field-notes are given in quotations. Only species of which specimens are contained in the collection are included in this list.

Thanks are due Mr. Robert Ridgway and Dr. C. W. Richmond of the United States National Museum, and Dr. A. K. Fisher of the Biological Survey of the U. S. Department of Agriculture for the loan of specimens which have been of great assistance in the preparation of this paper.

1. **Gavia lumme** (*Gunn.*). Red-throated Loon.— Homer, August 25, one adult; August 26, one immature. "Often seen at Homer, and no doubt breeds in that locality."

2. **Brachyramphus marmoratus** (*Gmel.*). Marbled Murrelet. — Homer, Aug. 23, one immature. "Common, and breeds on several of the islands of Kachimak Bay."

[1] Bull. Am. Mus. Nat. Hist., XVI, 1902, pp. 215–230.

3. **Uria troile californica** (*Bryant*). California Murre. — Homer, Aug. 24 to 31, three adults, three juvenals. "Anyone who has spent the night on the beach of Kachimak Bay will long remember this bird. Their loud and unmusical squawking is incessant and becomes very monotonous. It is a very common bird, and reported as breeding on Kadiak Island, near Homer."

4. **Stercorarius parasiticus** (*Linn.*). Parasitic Jaeger. — Homer, Aug. 24, one adult, dark phase. "Several specimens seen and one secured at Homer, but nothing was learned of their breeding. They are almost constantly on the wing, harassing the gulls."

5. **Rissa tridactyla pollicaris** *Ridgw.* Pacific Kittiwake. — Homer, Aug. 24 and 28, two adults. "This gull is the most abundant species of the family found on the Pacific coast of Alaska. It is extremely common at all points visited, and breeds in nearly all suitable localities. The predominance of young, or adult birds, differs greatly, according to locality. In the Alaska Peninsula region, the adults were seldom seen. At Juneau they were about equally divided, while at Seattle the ratio was about 50 to 1 in favor of the adults."

6. **Larus glaucescens** *Naum.* Glaucous-winged Gull. — Homer, Aug. 25, two immature specimens. "Quite common at Homer, and reported as breeding near there, but I have my doubts in regard to this, as I saw no suitable nesting sites in the locality indicated, unless its habits differ greatly from those I have observed in other places."

7. **Larus brachyrhynchus** *Rich.* Short-billed Gull. — Homer, Aug. 29, female immature. "The islands of Kachimak Bay are the breeding grounds of these birds. Coal Bay is a favorite feeding ground, and their cries make a constant din. The needle-fish, which are extremely plentiful, are their chief food, and thousands of birds may be seen at any time hovering over a school. They resemble the terns in their habits of feeding; rising about twenty feet above the

water, they descend with a quick dart, and dive below the surface. This is repeated, precisely as with the terns. A species of gull was found breeding on the low shores of Sheep Creek, about ten miles from tide-water, which I believe to be the Short-billed Gull. Half-grown young were seen on the creek the first of July. They appeared to be perfectly at ease in its swift current, and able to care for themselves, except in feeding.

8. **Larus philadelphia** (*Ord*). Bonaparte's Gull. — Homer, Aug. 24, two immature specimens. "No other specimens were seen and I doubt if it breeds at Homer."

9. **Phalacrocorax pelagicus robustus** *Ridgw.* Violet-Green Cormorant. — Homer, Aug. 24–27, three adults.

"Three species of Cormorants are found at Homer. The Violet-green was very numerous there and at all points visited, especially the low, rocky islands off the Alaska Peninsula. It breeds on a number of the islands of Kachimak Bay. Another species, having the white patch at the base of the tail, was found fairly common at Homer, but no specimens were secured. When the gulls, by their discordant cries, proclaim the discovery of a school of fish, every cormorant within hearing distance flocks to the scene, and in many cases so thoroughly appropriate the school to their own use that the gulls are compelled to seek other feeding grounds, as they do not relish diving into a mass of cormorants. The cormorants make no attempt to fish on their own account, but wait until the gulls discover the game and then appropriate it."

10. **Nettion carolinensis** (*Gmel.*). Green-winged Teal. — Homer, Aug. 30, male. "Found quite common at the head of Coal Bay during September. Nothing was learned of its breeding."

11. **Oidemia perspicillata** (*Linn.*). Surf Scoter. — Homer, Aug. 24, one adult.

12. **Tringa canutus** *Linn.* Knot. — Homer, August 23, one immature female.

13. **Tringa couesi** (*Ridgw.*). Aleutian Sandpiper. — Homer, August 27, one specimen.

14. **Tringa bairdii** (*Coues*). Baird's Sandpiper. — Homer, August 23, six specimens. "A fairly common migrant at Homer during August and September."

15. **Ereunetes pusillus** (*Linn.*). Semipalmated Sandpiper. — Homer, August 29, female, immature. "This was the only specimen secured, though very many of the following species were examined in the hope of finding it."

16. **Ereunetes occidentalis** *Lawr.* Western Sandpiper. — Homer, Aug. 23–29, eleven specimens. "The most numerous of the shore birds."

17. **Calidris arenaria** (*Linn.*). Sanderling. — Homer, August 29, five specimens. "Rather common, but irregular, during migrations."

18. **Totanus melanoleucus** (*Gmel.*). Greater Yellowlegs. — Homer, August 24, 25, ten specimens. "Common about the fresh and brackish water ponds near Homer during August and September."

19. **Heteractitis incanus** (*Gmel.*). Wandering Tatler. — Homer, August 24, male, immature. "The specimen secured was all that I noted."

20. **Actitis macularia** (*Linn.*). Spotted Sandpiper. — Sheep Creek, July 5, male adult. "Common along Sheep Creek, where it was breeding."

21. **Numenius borealis** (*Forst.*). Eskimo Curlew. — Kenai Mts., Aug. 11, one immature specimen; Homer, Aug. 24, one male. "A specimen of this curlew was taken on the barren grounds of Kenai Mountains, at an altitude of about 2000 feet. It had been feeding on the berries which were abundant in that locality. It was fairly common at Homer, and very shy."

22. **Squatarola squatarola** (*Linn.*). Black-bellied Plover. — Homer, Aug. 27, one adult. "This species was

rather rare at Homer, the two specimens secured being the only ones observed."

23. **Charadrius dominicus fulvus** (*Gmel.*). Pacific Golden Plover. — Homer, Aug. 23 to Sept. 27, three specimens. "Said to be fairly common at Homer during September. I took specimens during the latter part of August, and at Popof Island took one on December 15, which was in very poor condition and hardly able to fly, though it appeared to be uninjured."

24. **Ægialitis semipalmata** (*Bonap.*). Semipalmated Plover. — Homer, June 28, male and female adults.

25. **Arenaria interpres** (*Linn.*). Turnstone. — Homer, Aug. 27, male, immature; Aug. 23, an unsexed, immature specimen. Obviously to be referred to *interpres*.

26. **Arenaria melanocephala** (*Vig.*). Black Turnstone. —Homer, Aug. 27 to Sept. 26, seven specimens. "Common at Homer during migration."

27. **Lagopus lagopus** (*Linn.*). Willow Ptarmigan.— Homer, July 18, adult female, full breeding plumage; Sept. 29, one immature, two adults in transition plumage; Kenai Mts., July 10, one chick; July 14, two chicks; July 17, two chicks, two adult males in full breeding plumage; July 18, one adult female in full breeding plumage; Aug. 6, two adult males, one adult female at beginning of preliminary winter moult, four immature; Popof Island, Nov. 6–19, two immature, eight adults passing into winter plumage.

"Unlike the Canada Grouse the Willow Ptarmigan takes on its protective color during the fall. Its summer plumage makes it a very conspicuous object for quite a distance. Added to this is a loud proclaiming of the ptarmigan's presence, when danger approaches, by a series of cackling and scolding notes. From the bird's actions I am led to believe that its loud notes and conspicuous plumage are entirely for the protection of its young. These Ptarmigan are found about the alder patches just above timber line, and when disturbed cackle much after the manner of a domestic hen,

when the young will usually take wing and disappear among the alders, where their color assures them every protection. It is next to impossible to flush the parent birds until the young are out of sight, when they soon put a patch of alders between themselves and their tormentor, and in nearly every case go in the direction opposite to that taken by the young. When they have taken on their winter plumage and there is still no snow they are extremely shy, but become tame and depend entirely upon their color for protection when there is snow."

28. **Lagopus leucurus peninsularis,** subsp. nov.
Kenai White-tailed Ptarmigan.

Lagopus leucurus Osgood, Auk, XVIII, 1901, 180, part Cook Inlet specimen only; N. A. Fauna, No. 21, 1901, 75.

Chars. subsp.—In nuptial plumage differs from corresponding phase of plumage of *Lagopus leucurus* in having the black areas of greater extent, the buff areas much paler. In fall, transition or 'preliminary' plumage differs from similarly plumaged specimens of *Lagopus leucurus* in being decidedly grayer.

Description of type (Coll. Am. Mus. Nat. Hist., No. 76346, ♂ ad., August 11, 1901, Kenai Mts., Alaska, J. D. Figgins).—Upper surface black with broken and confluent buff and cream-buff bars; wings white, tertials and some of coverts same as back; tail white; centre of abdomen white, rest of under surface, from chin to and including under tail-coverts, heavily barred with black and cream buff, and margined terminally with whitish; a few feathers of the vermiculated fall plumage appear on the upper surface. Wing, 168 mm.; tail, 92; tarsus, 30; bill from nostril, 10.

Description of a specimen in transition plumage (Coll. Am. Mus. Nat. Hist., No. 76345, ♂ ad., Aug. 11, 1901, Kenai Mts., J. D. Figgins).—Crown and hind neck finely and irregularly barred with black, buff, and white; rest of the upper surface uniformly vermiculated with gray, black, and buff, the first-named prevailing; wings and tail white; tertials like back; abdominal region white; breast and flanks vermiculated with buff and black, the feathers often medianly black and with a white shaft-streak; throat still retaining barred nuptial plumage.

Of this new form the collection contains the following 26 specimens, all from the Kenai Mts.: Aug. 11, three adult females in nuptial dress, the transition plumage just beginning to appear; three adult males in nearly complete transition plumage; nine young birds passing from juvenal into transition

plumage; July 11, two specimens in juvenal plumage; July 17, one specimen passing from natal into juvenal plumage; July 10, eight specimens in natal down.

It is the first-named, the specimens in summer plumage, which led to the discovery that the Cook Inlet bird is separable from the Rocky Mountain and Coast Range form of *leucurus*. With only a single Cook Inlet specimen available—and that in fall plumage—and with no specimens of *leucurus* from the type locality for comparison, it was not unnatural that Mr. Osgood, misled by an agreement in measurements, should have referred the Cook Inlet bird, to *leucurus* of the Northern Rocky Mountains, separating as new the Colorado bird, of which specimens in transition plumage were available for comparison.

Summer specimens from Glacier Bay and White Pass, considered by him to be identical with the Cook Inlet bird are, in the light of this new material, obviously different from it, and are evidently to be placed with true *leucurus*. Whether they are still entitled to separation from Colorado specimens is doubtless a matter of opinion, but with the known differences between the specimens from the extreme northern and southern limits of the mainland range of *leucurus* reduced to a few millimetres in the length of the tail and wing, and with the type from a locality about midway between the extremes, there does not, in my opinion, remain sufficient reason for the recognition of two Rocky Mountain forms.

TABLE OF MEASUREMENTS.

Name.	Mus. No.	Coll.	Locality.	Sex.	Wing.	Tail.
Lagopus l. peninsularis.	76346	Am. Mus.	Kenai Mts.	♀	168	92
" " "	76347	"	"	♀?	164	86
" " "	76339	"	"	♂	171	95
" " "	76345	"	"	♂	174	90
" " "	76350	"	"	♀	166	92
" " "	76348	"	"	♂	167	92
" " "	—	Biol.Survey.	Cook Inlet.	♀	165	[1]
Lagopus leucurus.	165111	"	Glacier Bay.	♀	165	[2]
" "	165122	"	White Pass.	♀	165	84
" "	—	—	Rocky Mts., Lat 54	—	172	102[3]
" "	73583	Am. Mus.	Alberta, Lat. 51.30	♀	179	102
" "	73584	"	" "	♀	170	93
" "	142372	Biol. Surv.	Bold Mt., Colo.	♂	189	117
" "	156498	"	Mt. Ranier, Wash.	♀	171	90
" "	156505	"	" " "	♀	170	[2]

[1] Tail not fully grown. [2] Tail worn. [3] Swainson's type.

"Reared far above all timber, these interesting birds must depend upon their color for protection at all times. Found only on the bleak barren grounds, not even a blade of grass rises to offer them a retreat. Their color is an exact imitation of their rocky surroundings, and if the bird remains at rest it is impossible to detect it though only a few feet distant. When approached they crouch as closely to the ground as possible, usually near some small boulder, and remain thus while you are in motion, but if a stop is made they try to steal away and in that way reveal themselves. As soon as a movement is made they resume their former position. They are hard to flush, depending rather upon their color for safety than their wings. A low cackling when their young are disturbed are the only notes I have heard. The food of this ptarmigan is berries and the leaves of small plants. The principal berry resembles our blueberry in appearance and remains fresh the year round, falling from the plant only when a new crop is grown."

29. **Canachites canadensis osgoodi** (*Bishop*). Alaskan Spruce Grouse. — Thirty-four specimens, as follows: Homer June 28, two adults, nine in natal down; Sept. 6, two adults; Sept. 26, six adults; Sheep Creek, July 5, two adults; Kenai Mts., July 17, one adult, five passing from natal to juvenal plumage; Aug. 7, seven in juvenal plumage.

"In all the timber region I visited, the Canada Grouse was found common and breeding. Their chief food during early summer is the leaves of various deciduous bushes and spruce needles. About the 1st of August they repair to the edge of the barren grounds for berries which are then ripening. These are their food until September, when they return to the timber where raspberries and currants are abundant. During winter and spring their food consists entirely of spruce needles. Both adults and young appreciate their protective coloration, and when approached remain perfectly motionless until the danger is past. During the winter their color is to their disadvantage, and they become very shy, and will not allow a close approach."

30. **Circus hudsonius** (*Linn.*). Marsh Hawk.— Homer, Aug. 24, female.

"Hawks are not common in the Cook Inlet region, only an occasional specimen being seen. The above species is probably the most numerous. It was seen at all points visited."

31. **Accipiter velox** (*Wils.*). Sharp-shinned Hawk. — Homer, Sept. 29, female. "Seen occasionally in the timber belt."

32. **Falco peregrinus anatum** (*Bonap.*). Duck Hawk. — Homer, Aug. 28, female. "On Popof Island a pair of these birds were seen nearly every day. They preyed upon a flock of domestic pigeons, much to the latter's discomfort. Their flight is extremely swift, and they do not hesitate to take a pigeon on the wing and fall with it to the ground, as they are not able to carry it while flying."

33. **Falco columbarius** *Linn.* Pigeon Hawk. — Homer, Aug. 24, male.

34. **Surnia ulula caparoch** (*Müll.*). American Hawk Owl. — Kenai Mts., Aug. 6, male. "While at the upper edge of timber line on Kenai Mountains, a pair of these owls was occasionally seen. They were extremely shy, and I secured one of them only during the latter part of my stay there. Another specimen was seen during the latter part of September."

35. **Dryobates villosus leucomelas** (*Bodd.*). Northern Hairy Woodpecker. — Homer, Sept. 13, an adult female. "An occasional individual of this species was seen in the timber belt, but it was not common at any point visited."

36. **Dryobates pubescens nelsoni** *Oberholser.* Alaskan Downy Woodpecker. — Homer, Sept. 8 and 26, two specimens indistinguishable from the average eastern specimens of "*Dryobates pubescens medianus.*"

"This was the most numerous species of the family observed, its favorite haunt being the spruce and cottonwood thickets, where it was usually found in pairs."

37. **Picoides americanus fasciatus** *Baird.* Alaskan Three-toed Woodpecker. — Homer, Sept. 15, male. "This specimen was all I observed. It is undoubtedly rare, as the natives had never seen the species before."

38. **Empidonax traillii** (*Aud.*). Traill's Flycatcher. — Kenai Mts., Aug. 7, female. "Three specimens were seen at the upper edge of timber on Kenai Mountains, and one secured. It was not observed at any other place."

39. **Otocoris alpestris** (**arcticola** *Oberholser*). Alaskan Horned Lark. — Kenai Mts., July 8, a male passing from juvenal into first winter plumage. "Found breeding on the high barren grounds of Kenai Mountains."

40. **Cyanocitta stelleri borealis,** subsp. nov.

Kenai Jay.

Chars. subsp.—Similar to *Cyanocitta stelleri* (Vancouver Island specimens), but slightly larger, the head, neck, back, throat, and upper breast darker.

Description of type (No. 76482, Coll. Am. Mus. Nat. Hist., Homer, Alaska, Sept. 19, 1901, collected by J. D. Figgins).—Head, neck, throat, and upper breast dull black, back less intense, with a slight bluish (not brownish) cast; frontal streaks, lower back, lower breast, abdomen, flanks, and under tail-coverts china-blue; tail a somewhat deeper blue, the feathers indistinctly barred with black; wings deeper blue than tail, the inner feathers with broken black bars. Wing, 154 mm.; tail, 135; tarsus, 43; bill from posterior margin of nostril, 24.

Five specimens, four from Homer, September 1, 3, 19, and 26, and one from Sheep Creek, August 17, show that at the known northern limit of its range Steller's Jay has developed into a well-marked form easily distinguishable from true *stelleri* by the black instead of smoky-brown color of the head, neck, throat, upper breast, and back. In the color of these parts the form here named is indeed much nearer *Cyanocitta stelleri carlottæ* Osgood of Queen Charlotte Island from which, however, it differs chiefly in having the blue areas lighter in tint. The Kenai form, therefore, interestingly enough, is intermediate in color between the Queen Charlotte

Island bird and that inhabiting the coast, though geographically far removed from the former.

As the type of *stelleri* came from Nootka Sound, comparison in the present instance is made primarily with Vancouver Island specimens. The latter, however, do not appear[1] to differ from examples from the mainland of British Columbia, but specimens from Sitka show an approach to *borealis* in the darker, less brown color of the head, neck, throat, and back.

41. **Pica pica hudsonica** (*Sab.*). American Magpie. — Kenai Mts., July 7, one immature male; Homer, Sept. 18 and 29, two specimens; Sand Point, Nov. 10 and 15, two specimens. "This bird was found common in all localities visited, and it is resident wherever found. It was especially numerous along the coast of the Alaska Peninsula and neighboring islands."

42. **Perisoreus canadensis fumifrons** *Ridgw.* Alaskan Jay. — Homer, three adults, Sept. 16 to 26; one juvenal, June 5; Kenai Mts., one juvenal, July 18; Sheep Creek, one adult, Aug. 18. "This and Steller's Jay were found fairly common in the timber belt. They became very bold and came into camp, where an abundance of food was obtainable."

43. **Scolecophagus carolinus** (*Müll.*). Rusty Blackbird. —Sheep Creek, Aug. 18, male. "One specimen taken on Sheep Creek, near Homer, was the only representative of the family observed."

44. **Pinicola enucleator alascensis** *Ridgw.* Alaskan Pine Grosbeak. — Sheep Creek, July 5, male adult; Homer, Sept. 8 to 29, eight specimens. "The patches of cottonwoods were the favorite haunts of this bird. They were never found in the spruce timber except while perched upon the topmost branch of a dead tree, where they remained but a few minutes. During heavy rainstorms they repair to the lower underbrush and even the low grass."

45. **Spinus pinus** (*Wils.*). Pine Siskin. — Homer, Sept.

[1] *Cf.* Fisher, Condor, IV, 1902, 41.

8, two examples in yellowish juvenal plumage. "Very common during early summer on Kenai Peninsula, where many large flocks were seen migrating to the northward during July. A few were seen during August and September, and I am inclined to the belief that it breeds very rarely there."

46. **Ammodramus sandwichensis alaudinus** (*Bonap.*). Western Savanna Sparrow. — Homer, June 5, two; Aug. 21, and Sept. 8, four; Sheep Creek, Aug. 17 and 18, two; Kenai Mts., Aug. 11, in all, eight specimens. "Found breeding on the low sandy spit at Homer. Its nest was well concealed in the coarse grass. It was entirely covered, and the entrance to the three nests examined was on the southern side."

47. **Zonotrichia leucophrys gambeli** (*Nutt.*). Intermediate Sparrow. — One immature specimen. "Occasionally seen on the high grounds of Kenai Mountains a few hundred feet above timber line. It was no doubt breeding, as it was seen at various times during the summer."

48. **Zonotrichia coronata** (*Pall.*). Golden-crowned Sparrow. — Kenai Mts., Aug. 9, male, im.; Homer, Aug. 28 to Sept, 8, five specimens. "This species was not seen until late summer at Homer, when it became very common."

49. **Junco hyemalis** (*Linn.*). Slate-colored Junco. — Five specimens as follows: Kenai Mts., Aug. 7 and 9: Homer, Aug. 25 and Sept. 12. "Extensive alder patches just above timber line were the breeding ground of this Junco. They are quite common and were found in all such localities visited."

50. **Spizella monticola ochracea** *Brewst.* Western Tree Sparrow. — Homer, Sept. 8, one specimen.

51. **Melospiza cinerea kenaiensis** *Ridgw.* Kenai Song Sparrow. — Two specimens from Homer, Oct. 12. "These specimens were the only ones observed."

52. **Melospiza cinerea** (*Gmel.*). Aleutian Song Sparrow. — Ten specimens, Sand Point, Popof Island, Oct. 20 to 30.

"I found this sparrow fairly common on Popof Island, where it is resident. Its song greatly resembles that of the eastern Song Sparrow and is heard throughout the year."

53. **Passerella iliaca unalaschensis** (*Gmel*). Shumagin Fox Sparrow. — An adult female taken at Homer, June 5, agrees with Shumagin Island specimens of *unalaschensis*.

54. **Passerella iliaca annectens** *Ridgw.* Yakutat Fox Sparrow. — Kenai Mts., three specimens, one in juvenal plumage, Aug. 9 and 11; Homer, one, Aug. 28. These birds agree with June specimens of *annectens* from Yakutat Bay, the only ones available for comparison. "The low, swampy ground in the timber belt is a favorite haunt of this interesting bird, but it is not common."

55. **Lanius borealis** *Vieill.* Northern Shrike. — Homer, Sept. 15, two specimens. "Several shrikes were seen on Kenai Mountains just above the edge of timber line. They were found in pairs during the entire summer and no doubt breed there."

56. **Helminthophila celata lutescens** *Ridgw.* Lutescent Warbler. — Sheep Creek, Aug. 8, four specimens; Kenai Mts., Aug. 9, two specimens; Aug. 17, one specimen, passing from juvenal to first winter plumage. "I found this Warbler fairly common along all streams in the timber belt even to its highest limits, where it breeds."

57. **Dendroica æstiva rubiginosa** (*Pall.*). Alaskan Yellow Warbler.—Three immature males as follows: Kenai Mts., Aug. 14; Sheep Creek, Aug. 17; and Homer, Aug. 28. "Found occasionally at the upper edge of timber line on Kenai Mountains."

58. **Dendroica coronata** (*Linn.*). Myrtle Warbler. — Kenai Mts., Aug. 17, Sheep Creek, Aug. 18, two specimens. "Two specimens were seen during June and July, and several during August and September."

59. **Dendroica striata** (*Forst.*). Black-poll Warbler. — Sheep Creek, July 5, adult female. "Noted at several

places on Kenai Peninsula in the Sheep Creek region, and no doubt breeds there."

60. **Dendroica townsendi** (*Towns.*). Townsend's Warbler. — Two specimens, taken respectively in the Kenai Mts., Aug. 14, and at Sheep Creek, Aug. 17, considerably extend the range of this species to the westward. "Two specimens taken on Kenai Peninsula were all I observed."

61. **Seiurus noveboracensis notabilis** *Ridgw.* Grinnell's Water-Thrush. — Homer, Aug. 18, male, immature. "This undoubtedly is a rare bird on Kenai, one specimen being all I noted."

61. **Wilsonia pusilla pileolata** (*Pall.*). Pileolated Warbler. — Sheep Creek, three specimens, July 5, Aug. 17, and 18; Kenai Mts., eight specimens, Aug. 9 to 17.

"The Pileolated Warbler is undoubtedly the commonest species of warbler found in the Kenai region. It was found along all the streams in the timber belt and the alder patches just above timber line, where it breeds, as it was seen in pairs during the summer."

63. **Anthus pensilvanicus** (*Lath.*). American Pipit. — Five specimens from Homer, Aug. 24–29. "During the autumn this bird is seen in all suitable localities from timber line to an altitude of about 4000 feet. I did not observe it during the summer, although I was in a good locality for it."

64. **Parus hudsonius columbianus** (*Rhoads.*). Columbian Chickadee.—Homer, June 28, adult male, September 12, two specimens, first winter plumage. "Not common, but seen at all places visited on Kenai in the timber belt. It was usually found in the dead spruce groves of the more open country."

The facts that adult Hudsonian Chickadees, in common with their congeners, have only a single annual molt, and that their plumage is subject to sufficient abrasion and fading to render imperceptible or obscure in spring specimens the characters shown by them in the fall, add greatly to the difficulties

of a proper interpretation of the geographical variations shown by members of this group. On the other hand, these birds are so nearly permanent residents that fall specimens may be used in comparison with little doubt that they represent the form of the locality where they were taken.

In attempting, therefore, to determine the relationships of the Hudsonian Chickadees above mentioned, I have used the two examples in first winter plumage rather than the one in worn breeding dress. Applying this principle to the group at large, the material loaned by Mr. Ridgway and Dr. Fisher, in connection with a good series in the American Museum collection (in all 90 specimens), it appears to be separable into four races, as follows:

1. *Parus hudsonicus* Forst.[1]— Crown hair = brown, with a strong tinge of Prout's brown, decidedly the *brownest* bird of the group; wing, 65 mm.; tail, 65; bill from nostril, 7.7. (U. S. N. M., No. 89279, Moose Factory, H. B.). British America, from the west side of Hudson Bay northwestward to the lower Yukon. (Type from Ft. Severn, Hudson Bay.)

2. *Parus hudsonicus littoralis* Bryant.[2]— Crown deep hair = brown without the decided brownish tinge of *hudsonicus;* wing, 62; tail, 62; bill from nostril, 7 (Am. Mus. Nat. Hist., No. 25895, Stewiacke, N. S.). British America east and south of Hudson Bay, northern New York, northern New England. (Type from Yarmouth, N. S.)

3. *Parus hudsonicus stoneyi* (Ridgw.).[3]— Crown pale hair = brown; wing, 68; tail, 67; bill from nostril, 8. (U. S. Nat. Mus., No. 110316, Putnam River, Alaska, northwestern Alaska.) (Type from Kowak River, Alaska.)

4. *Parus hudsonicus columbianus* Rhoads.[4]— Crown slaty drab without brownish tinge; wing, 66.5; tail, 67; bill from nostril, 8. (Biol. Surv., No. 155741, Smoky Valley, Alberta.) Rocky Mts. from Montana north to ————; Kenai Peninsula, Alaska. (Type from Field, B. C.)

While no series of specimens from the type locality of *hudsonicus* is available there is no reason to doubt, in view of the comparatively slight variation exhibited by the group, that

[1] Philos. Trans., LXII, 1772, 383, 430.
[2] Proc. Bost. Soc. N. H., IX, 1863, 368.
[3] Manual N. A. Birds, 1887, 591.
[4] Auk, X, 1893, 310.

specimens from the interior of British America fairly represent typical *hudsonicus*, of which, with this application of the name accepted, *evura* Coues becomes an undisputed synonym.

Labrador specimens (*ungava* Rhoads) are larger than those from New Brunswick and Nova Scotia, and present slight average differences in color, but do not in my opinion require recognition by name.

The advisability of referring Kenai Peninsula specimens to *columbianus* will no doubt be questioned. It is true that the known northern limit of the Rocky Mountain range of *columbianus* is far distant from Cook Inlet, and it is quite likely that the form does not range continuously through the intervening area. I do not see, however, that this has anything to do with the matter. Zoölogical nomenclature is designed to name zoölogical, not geographical, conditions. It is quite as important to point out resemblances as to emphasize differences. The two fall specimens from Homer are absolutely indistinguishable from specimens from Alberta, and there is, therefore, no valid excuse for refusing to recognize this identity by name.

In spring and early summer specimens the differences in color above mentioned, as has been said, largely disappear, and this fact, in connection with the very limited number of specimens of all the forms, except *littoralis*, which have been taken at this season and are available for study in the present connection, render it impossible properly to characterize at present these races in breeding dress.

65. **Regulus satrapa olivaceus** *Baird.* Western Golden-crowned Kinglet. — A male and female from Homer, Sept. 26, and a male from Sheep Creek, Aug. 18.

66. **Hylocichla aliciæ** (*Baird*). Gray-cheeked Thrush. — One adult specimen, sex not given, from Sheep Creek, July 5, 1901. This example is decidedly paler than eastern examples of this species.

67. **Hylocichla ustulatus almæ** *Oberholser.* Alma's Thrush. — An adult male from Sheep Creek, July 5, 1901, extends the breeding range of this form. "Several seen on

Kenai during the summer. A nest containing two fresh eggs was found the latter part of June. Their song resembles that of the Wood Thrush, and their habits are much the same."

68. **Ixoreus nævius** (*Gmel.*). VARIED THRUSH. — Homer, male adult and male juvenal, Sept. 17. "These two specimens were all I noted."

Article XX.— A PRELIMINARY STUDY OF THE SOUTH AMERICAN OPOSSUMS OF THE GENUS DIDELPHIS.

By J. A. Allen.

Introductory.

About a year since, I published [1] 'A Preliminary Study of the North American Opossums of the Genus *Didelphis*.' Shortly after, I had opportunity to study the material relating to this genus contained in the British Museum, through the kindness of Mr. Oldfield Thomas, the Curator of Mammals. The present paper is based almost wholly on the material thus generously placed at my disposal. It includes specimens from many different and widely separated localities, some of which are represented by a considerable number of specimens. Among them are practically topotypes of Azara's 'Micouré premier,' and of the forms described by Lund and von Ihering from Southern Brazil. I also had the pleasure of examining the types of Bennett's *Didelphis californica* and *D. breviceps*.

In a group so notoriously subject to variation due to age and individual differentiation, it is necessary to examine a very large amount of material in order to reach satisfactory results. That now available is only sufficient for a preliminary survey of the field, and the conclusions reached are necessarily tentative, and are presented with some hesitation, although the material studied by me at the British Museum, combined with that in the American Museum of Natural History, is probably greatly in excess of that examined by any previous investigator of the group. Having in my former paper considered in some detail the subject of sexual and individual variation, and variations due to age, it is sufficient in the present connection to say that the South American forms, as would be expected, vary in these respects

[1] This Bulletin, XIV, pp. 149–188, pll. xxii–xxv, June 15, 1901

in the same manner and to the same degree as the northern members of the group.

Historical Résumé and Nomenclature.

As in the case of the North American forms, the South American present puzzling questions of synonomy, some of which have already in part been considered.[1] The first name applied as a species name to any member of the restricted genus *Didelphis* was *marsupialis* (Linnæus, Syst. Nat., 1758, p. 54), given to a group of forms comprising all the large opossums then known. Owing to this fact various writers, from Temminck and Waterhouse down to the present time, have treated the name as indeterminate. There is no doubt, however, of its exclusive relation to the large opossums of the restricted *Didelphis* group; the trouble is satisfactorily to fix the name upon some one of the several components of the original *marsupialis*.

At one time I favored restricting the name *marsupialis* to the Virginia opossum (this Bulletin, XIII, 1900, p. 187), on the ground that the reference to Tyson was the first of the citations given by Linnæus that was positively identifiable.

Later (*op. cit.*, XIV, 1901, p. 164), through the application of the principle of elimination, I favored fixing the name on the large Mexican species, on the basis of the Linnæan reference to Hernandez, the large Guiana form having been taken out of the group by Zimmermann in 1780, the Virginian species by Kerr in 1792, the Paraguayan and South Brazilian respectively in 1816 and 1826, leaving only *californica* of Bennett of the members originally composing it. Mr. Oldfield Thomas, however, has objected to this (Amer. Nat. XXXV, Feb. 1901, p. 144; Ann. and Mag. Nat. Hist. (7) VIII, Aug. 1901, p. 153), on the ground that Linnæus's only reference in the sixth edition of the 'Systema Naturæ,' and the first in order of sequence in the tenth edition, is to Seba, and that Seba's animal is beyond doubt the ordinary large dark opossum of northeastern South America, subsequently named *Didelphis karkinophaga*. Although at one time I was

[1] *Cf.* this Bulletin, XIII, 1900, pp. 185–187.

not convinced that Seba's animal (pl. xxxix) was identifiable a reëxamination of the case leads me to accept Mr. Thomas's conclusion.[1]

The *Didelphis marsupialis* case being settled, the next names in order of time for the South American large opossums are *D. karkinophaga* Zimmermann, 1780, *D. carcinophaga* Boddaert, 1784, and *D. cancrivora* Gmelin, 1788, all of which were based on Buffon's 'le Crabier' from Cayenne, and are therefore all synonyms of *D. marsupialis* as now restricted. Next in order of date are Oken's names for the large opossums of both North and South America, of which he recognized five species, giving new names to four of them, as follows:

(1) *Did*[*elphys*] *cancrivora* (Lehrbuch der Naturgeschichte, Theil III, Abt. ii, 1816, p. 1146). Based on Buffon's 'le Crabire,' and hence = *Didelphis cancrivora* Gmelin.

(2) *Did. paraguayensis* (*l. c.*, p. 1147). Based primarily on the 'Micouré premier' of Azara, with which he correctly associates the 'Tai-ibi Brasiliensibus' of Marcgrave. = *Didelphis azaræ* Temminck, 1825.

(3) *Did. austro-americana* (*l. c.*, p. 1148). Relates mainly to the large South American opossums of the *Didelphis* group, but also includes references to species of *Metachirus* and *Caluromys*. = *Didelphis marsupialis* Linn. mainly.

(4) *Did. mes-americana* (*l. c.*, p. 1152). Relates primarily to the Mexican 'Tlaqatzin,' or to the "Tlaqatzin in Neu Spanien (nördl. Mexico), auch in andern Gegenden Amerikas unter verschiedenen Namen." These other names and regions include the "Çarigueya an der Küste von Brasilien, Jupatiima im Innern, Taibi in Paraguay," etc., of South America, and the 'Manicu' of the lesser Antilles, with references also to Florida and Darien. Although *D. mes-americana* is thus composite,

[1] Mr. Thomas says (Ann. and Mag. Nat. Hist. (7) VIII, Aug. 1901, p. 153): "The evidence of the sixth edition of the 'Systema,' where Seba, and Seba only, is quoted, shows what animal Linnæus had in his mind when speaking of *marsupialis*." This statement can hardly be taken strictly, as in the sixth edition (p. 10), Linnæus did not use the name *marsupialis*, but simply *Didelphis*, of which he recognized two groups (species?), namely, "1. *Didelphis mammis intra abdomen*," and "2. *Didelphis mammis extra abdomen*," citing Seba only under each. Under the first he gives "Seb. thes. I, t. 36, f. 1, 2 & t. 39." The first plate reference here cited later became the exclusive basis of Linnæus's *Didelphis opossum* (*cf.* Thomas, Cat. Marsup. and Monotr., 1888, p. 329), while the other became in part the basis of his *D. marsupialis*. He thus, in the tenth edition, made two species of his No. 1 of the sixth edition, citing of Seba's plates only pl. xxxix under his *D. marsupialis*, and in so doing restricted his *marsupialis*, so far as Seba is concerned, to pl. xxxix.

he first describes at length the large *Didelphis*, or 'Tlaqatzin,' of Mexico, with which he constantly compares the other forms described with equal fulness later, showing that the Mexican 'Tlaqatzin' was the animal he 'had in his mind' when describing *mes-americana*. Hence there seems to be no good reason for not applying the usual rule to the present case and restrict the name *mes-americana* to the large opossum of 'northern Mexico' ("nördl. Mexico"), since it long antedates Bennett's and other later names for the same animal.

(5) *Did. boreo-americana* (*l. c.*, p. 1158). Relates exclusively to the opossum of the eastern United States ("nur in Virginien, Lusiana, Kanada"; also "im Lande der Illiner"). Hence = *Didelphis virginiana* Kerr.

The first intelligent account of the large opossums, based on the comparison of considerable material, was published by Temminck in 1825 (Mon. Mamm., 1825–1827, Deux. Mon., 1825, pp. 27–35), who clearly distinguished three species, and properly allocated their principal synonyms. The first is his *Didelphis virginiana*, correctly characterized and properly assigned to North America "depuis le Mexique jusque dans les provinces septentrionales des États-Unis." The second is his *Didelphis azaræ*, described from specimens seen in European museums, and identified with the 'Micouré premier, ou Micouré proprement dit' of Azara, and which he says is found "aù Brésil, où il est très-répandu," and, of course, in Paraguay. His third species is *Didelphis cancrivora*, which he identifies with "le Grand Philander oriental de Seba, Thes. Vol. I, p. 64, tab. 38, fig. 1 [*lege* tab. 39];" he says it is found over a great part of South America, but especially in "le Guiane et le Brésil." It is Buffon's 'le Crabier,' which he cites, as also Boddaert's and Gmelin's names based thereon; but he makes no reference, under any of his species, to *D. marsupialis* Linn. Yet in citing Seba, he cites the primary basis, according to Thomas (*cf. antea*, p. 251, footnote), of Linnæus's *marsupialis*.

In his otherwise creditable notice of this group of opossums Temminck makes the singular mistake of reversing the colors of the ears of his *D. azaræ*, which he says are yellow at

the base with the rest black,[1] whereas just the opposite is true, as noted by Wagner and Hensel.

In 1826 Wied (Beitr. zur Naturg. von Brasilien, II, 1826, pp. 387–400) recognized what he considered to be two species of true *Didelphis* from southern Brazil, one of which he identified with *D. marsupialis* Linn., and the other he provisionally described as new, under the name *Didelphys aurita*, on the basis of a single female specimen from Villa Viçoza, Rio Peruhype, in southeastern Brazil. Here is named for the first time the large black-eared opossum of southern Brazil, to which both these names relate.

In 1841 Lund (Kongl. Dansk. Vidensk. Selsk. Afhandl., VIII, 1841, p. 236) described the *azaræ* type of opossum occurring at Lagoa Santa as *Didelphis albiventris*, and a year later Wagner (Arch. f. Naturg. 1842, i, 358) renamed the same animal, from practically the same region, *Didelphys pœcilotis*, which latter name has been generally taken instead of Lund's, especially by German writers. In 1844 Schinz (Syn. Mamm., 1844, p. 504), based the name *Didelphys pœcilonota* on Rio Grande do Sul specimens, while Ihering has recently given the name *Didelphys lechei* to the dark phase of the *azaræ* type from the same region, and the name *Didelphys koseritzi* to the dark phase of the *aurita* type of the same region.

In 1900 I described (this Bulletin, XIII, pp. 192, 193) two subspecies of the *marsupialis* group from, respectively, eastern and western Colombia, under the names *D. karkinophaga colombica* and *D. k. caucæ;* and also (*l. c.*, p. 191) a black form of the *D. azaræ* (= *paraguayensis*) group, from southeastern Peru, under the name *Didelphis pernigra.* At this time I had not previously seen specimens of the *D. azaræ* group, and was hence strongly impressed with its distinctness from any of the forms of *Didelphis* then known to me. I was therefore greatly surprised, a year later, to find it only a form of the so-called *D. azaræ.*

Species and Subspecies of Didelphis.

The South American forms of *Didelphis* are separable

[1] See *op. cit.*,, footnote to p. 27, and the text, pp. 30 and 31.

into two distinct groups, through well-marked differences of size, coloration, and cranial characters, namely, the *D. marsupialis* group and the *D. 'azaræ'* or *paraguayensis* group. The first ranges from Panama southward, extending down the Pacific coast as far, at least, as northern Peru, and also across northern South America from western Colombia to Trinidad, and southward east of the Andes, to Bolivia, northern Argentina, Uruguay, and southern Brazil. It is not, however, the same throughout this vast range, but is separable into a number of well-marked forms, the extremes of which, while widely diverse, are connected by intergradation. The smallest forms of this group are considerably larger than the largest forms of the *paraguayensis* group. The coloration is also notably different, the *marsupialis* group having wholly black ears [1] and very indistinct head markings, while in the *paraguayensis* group the ears are either wholly or in large part flesh-colored, and the black head markings are generally very sharply defined on a white ground. In the latter the skull is relatively shorter and less attenuated, the 4th premolar in both jaws is relatively much larger and thicker or more peg-shaped, and the superior border of the zygoma is formed posteriorly by the squamosal instead of in part by the posterior extension of the malar. This character alone is so constant and well marked as to readily differentiate the skulls of the two forms.

The *paraguayensis* group is found from the Rio de la Plata northward to central Minas Geraes, Matto Grosso, and western Bolivia, and thence northward in the Andean region through Peru and Ecuador, reaching the coast at Callao and probably elsewhere in Peru, and thence ranging eastward through the Eastern Cordillera in Colombia and Venezuela to Merida. It appears to be absent from western and northern Colombia, northern and eastern Venezuela, including the Orinoco basin, and from the whole Amazonian region east of the Andean foothills, and hence from all of central and northern

[1] By 'ear' is meant, in this connection, the external ear or pinna only, exclusive of the meatus, which latter often varies individually in specimens from the same locality in all the forms of the *marsupialis* and *mes-americana* (*californica*) groups, in which the external meatus may be yellowish while the pinna is wholly black.

Brazil. It is thus an animal of the Cordilleras, the mountainous portion of southern Brazil, and the more southern pampas. This, at least, is the evidence afforded by the present material and the literature of the subject. The two groups thus overlap each other geographically only in southern Brazil, northern Argentina, and in parts of Bolivia, and again at the northward over limited portions of Colombia and Venezuela.

In respect to the distribution of these two groups in Ecuador and Peru, it is of interest to note that the late Mr. P. O. Simons, on his collecting trip for the British Museum during the years 1898–1901, from the coast region of Ecuador southward and eastward to southeastern Peru and the adjoining part of Bolivia, sent only specimens of the *marsupialis* group from the low coast region west of the Andes, from the Department of Piura in Peru northward to Guayaquil, and only specimens of the *paraguayensis* group from the interior of Ecuador, Peru, and Bolivia.

The *marsupialis* group is not very sharply separable from the large opossums of Mexico and the United States. Neither intergradation between the North American and South American forms, nor the reverse, has as yet been established, owing to the lack of material from large portions of Central America. It is evident, however, that the relationship is close among all these forms, in comparison with their sharp differentiation from all the members of the *paraguayensis* group.

The extraordinary amount of variation in individuals of the same subspecies, from even the same locality, in respect to size and coloration, in the relative length of the tail and in cranial characters, combined with dimorphic conditions in coloration, renders the discrimination of local forms a very difficult matter, and at best, with the limited material as yet available for examination, exceedingly unsatisfactory. Beginning at the northward, we have, first, the large *virginiana* type, white-headed, short-tailed, and light-colored, with the margin of the ears and the tips of the toes and much the greater part of the tail white, and never, so far as known, running into a melanistic phase; in its southern subspecies, *pigra*, the underfur is more extensively tipped with black,

the tail becomes slightly longer, the white on the ears, tail and toes is reduced, and on the latter is of irregular presence, and there is a decided tendency to melanism. A very similar dichromatic form occurs in southern Texas, with, however, differently shaped nasals. In Mexico the same general type prevails, but the head is much darker, the tail is generally, but not always, much longer, the size varies with locality, as also do other features. This same general style, with local variations, ranges over Central and northern South America, being everywhere dichromatic, and over eastern South America to Uruguay, with, however, over this last area, a tendency to a better-defined pattern of head markings. Adopting the changes in nomenclature for the Mexican and Paraguayan types proposed above, the members of the genus *Didelphis* will stand as follows:

List of the Species and Subspecies.

I. Marsupialis Group.

1. *Didelphis virginiana* Kerr. — Eastern United States, except the Gulf coast.
2. *Didelphis virginiana pigra* Bangs. — Southeastern Georgia, Florida, and the Gulf coast region to Texas.
3. *Didelphis mes-americana* Oken.

Didelphis marsupialis Allen, Bull. Am. Mus. Nat. Hist. XIV, 1901, 166. Not *D. marsupialis* Linn. restr.

Mexico, from Puebla and Guerrero northward. Probably should be separated into several local forms.[1]

4. *Didelphis mes-americana texensis* Allen. — Rio Grande region of Texas and Mexico.

[1] In this connection it may be of interest to note the results of an examination of the types, so far as they are extant, of Bennett's *Didelphis californica* and *D. breviceps*.

A skull in the British Museum of one of the two specimens on which *D. californica* Bennett was based (the skins are not extant) resembles, in the character of the nasals, the Vera Cruz type of Mexican opossum, named by me *D. m. tabascensis*. As, however, Mr. Bennett's material, described as "from that part of California which adjoins Mexico," of which this formed a part, appears to have been unquestionably Sonoran, it seems better not to disturb the name already bestowed upon the east Mexican form; especially in view of the inconstancy of the form of the nasals in all the forms. The alleged type skull is labelled: "Taken from one of the *Types* of *D. californica* Bennett, P. Z. S. 1833, p. 40. No. 1141a. Brit. Mus. Reg. 55-12-26-190. *Didelphys marsupialis*, L. Loc. California. Ex. Coll. Zoöl. Soc."

The type of *D. breviceps* Bennett, still extant in the British Museum, is a rather young specimen. On removal of the skull from the skin for examination it was found to agree in the form of the nasals with Sinaloa specimens of corresponding age.

5. *Didelphis mes-americana tabascensis* Allen. — Southern Mexico and Guatemala.
6. *Didelphis yucatanensis* Allen. — Yucatan.
7. *Didelphis yucatanensis cozumelæ* Merriam. — Cozumel Island, Yucatan.
8. *Didelphis richmondi* Allen. — Nicaragua.
9. *Didelphis marsupialis* Linn. (restr.). — Guiana and eastern Venezuela.
10. *Didelphis marsupialis insularis*, subsp. nov. (p. 259).— Island of Trinidad and Lesser Antilles.
11. *Didelphis marsupialis colombica* Allen. — Eastern Colombia and (probably) northern Venezuela.
12. *Didelphis marsupialis caucæ* Allen. — Southwestern Colombia.
13. *Didelphis marsupialis etensis*, subsp. nov. (p. 262). — Pacific coast region, west of the Andean chain, from northern Peru to Panama.
14. *Didelphis marsupialis battyi* Thomas. — Coiba Island, Panama.
15. *Didelphis marsupialis aurita* Wied. — Southern Brazil.

II. Paraguayensis Group.

16. *Didelphis paraguayensis* Oken. — Northern Argentina, Paraguay, and southern Brazil.
17. *Didelphis paraguayensis pernigra* Allen. — Southeastern Peru, into Bolivia.
18. *Didelphis paraguayensis andina*, subsp. nov. (p. 272).— Andean region of northern Peru and Ecuador.
19. *Didelphis paraguayensis meridensis*, subsp. nov. (p. 274). — The eastern Cordilleras of Colombia and Venezuela.

Descriptions of the South American Species and Subspecies.

Didelphis marsupialis *Linn.*

Philander, maximus, orientalis, Seba, Thesaurus, I, 1734, 64, pl. xxxix. "Amboine," in error = Guiana.

Didelphis mammis intra abdomen Linn., Syst. Nat. ed. 6, 1748, 10 = Philander of Seba, pll. xxxvi, figs. 1, 2, xxxix (part).

Didelphis marsupialis Linn., Syst. Nat. ed. 10, I, 1758, 54 (part); ed. 12, I, 1776, 72 (part). — Erxleben, Syst. Reg. Anim. 1777, 73 (part). — Gmelin, Syst. Nat. I, 1788, 105, ex Schreber. — Thomas, Amer. Nat. XXXV, Feb. 1901, 144, (nomenclature); Ann. and Mag. Nat. Hist. (7) VIII, Aug. 1901, 153 (British Guiana, nomenclature).

Didelphys marsupialis Schreber, Säug. III, 1778, 536 (mainly; not pl. cxlv*, which is *D. virginiana.*) — Also in part of most later compilers.

Didelphys marsupialis var. *typica* Thomas, Cat. Marsup. and Monotr. 1888, 323 (part).

Le Crabier, Buffon, Hist. Nat. Suppl. III, 1776, 272, pl. liv. Cayenne.

Didelphis karkinophaga Zimmermann, Geogr. Gesch. II, 1780, 266 = Le Crabier, Buffon. — Allen & Chapman, Bull. Am. Mus. Nat. Hist. IX, 1897, 30 (part). — Allen, Proc. Biol. Soc. Wash. XIV, 92, June 19, 1901 (nomenclature); Bull. Am. Mus. Nat. Hist. XIV, 1901, 151, 153 (in text).

Didelphis cancrivora Gmelin, Syst. Nat. I, 1788, 108 = Le Crabier, Buffon. — Desmarest, Nouv. Dict. d' Hist. Nat. VI, 1803, 458. — Temminck, Mon. Mamm. 2° Mon. 1825, 32, pl. v, skull and skeleton.

Didelphys cancrivora Wagner, Schreber's Säug. Suppl. III, 1843, 41; V, 1855, 225. — Waterhouse, Nat. Hist. Mamm. I, 1846, 473. — Cabanis, Schomburgk's Reisen Brit.-Guiana, III, 1848, 777.

Type Locality.—Guiana.

Geographical Distribution.— Guiana, eastern Venezuela, and probably southward into northern Brazil. Exact range not known.

Above yellowish white, varied with black; underfur yellowish white, the tips of the longer fibres blackish; overhair stiff, bristly, white basally, black on apical half. A narrow blackish eyering, but no other facial markings, the whole head being dingy yellowish white with the tips of the hairs blackish, giving a slight general dusky wash. Ventral surface yellowish white, with a slight dusky brown wash, formed by the tips of the longer hairs. Fore and hind limbs, including upper surface of feet, deep brownish black. Ears large, wholly black. Tail black for the basal two-thirds of the naked portion, apical third light flesh-color.

Measurements. — Two males from the Kanuka Mountains, British Guiana, measure: Total length, 762 and 775 mm.; head and body, 381 and 381; tail, 381 and 394; hind foot, 57; ear, 57. A female (same locality) measures: Total length, 712; head and body, 330; tail, 382; hind foot, 51; ear, 51. Another female from Mapures, Venezuela, measures: Total length, 776; head and body, 357; head and body, 419; hind foot, 54; ear, 52. *Skull:* Three males, total length, 101 (95–107); basal length, 92 (86–98); nasals, 48 (45–50); zygomatic breadth, 51 (48–55); postorbital breadth, 22 (20–24.5); postorbital con-

striction, 11 (11–11.5); occipital breadth, 29; breadth at canines, 18.7 (17–20); upper toothrow, 33.9 (33–35.3); molar series, 19.3 (19–20).

The above description is based on an adult male, from Better Hope, Demerara. Three other specimens from the Kanuka Mountains (alt. 300 feet), Guiana, agree in coloration and skull characters, except that one is in the gray phase with whitish overhairs, the others being in the black phase. A specimen from Mapures, Venezuela, is also similar, but has the underfur stained basally with ochraceous brown or gamboge, and the long overhair is mostly white, but some of it is apically black, as in the black phase.

Specimens examined:

Guiana: Better Hope, Demerara, 1 specimen; Kanuka Mountains, altitude 300 feet, British Guiana, 3 specimens.

Venezuela: Mapures, 1 specimen.

Total, 5 specimens, coll. British Museum.

The true *marsupialis* of Guiana and the Lower Orinoco region differs markedly—through its lighter coloration, absence of decided markings on the head, and its generally whitish color, smaller size, and longer tail — from any of the forms of northern South America, and still more from *D. aurita* of southern Brazil, as will be noticed later.

Didelphis marsupialis insularis, subsp. nov.

Didelphys marsupialis Thomas, Journ. Trinidad Field Nat. Club, I, April, 1893, 11.

Didelphis marsupialis Allen & Chapman, Bull. Am. Mus. Nat. Hist. V, 1893, 230.

Didelphis karkinophaga Allen & Chapman, Bull. Am. Mus. Nat. Hist. IX, 1897, 23 (Trinidad), 30 (Dominica). — Allen, *ibid.* XIV, 1901, 186 (measurements).

Type, No. $\frac{7740}{61124}$, ♂ ad., Caparo, Trinidad, March 19, 1894; coll. Frank M. Chapman.

Head almost wholly yellowish white to nape, with a very narrow brownish eyering; in fresh long pelage the hairs on top of head slightly tipped with dusky, giving a slight dingy tone, and sometimes tending to form a dusky median band over the top of the head. Underfur almost wholly yellowish white, a few of the coarser fibres tipped with blackish, mainly along the middle of the back; at base over nape and shoulders brownish ochraceous; long stiff overhair wholly white in some individuals, wholly black in others, or black and white mixed in still others. Below pale yellow or yellowish white, the tips of a few of the longest hairs blackish, but so few as scarcely to affect the general coloration. Fore limbs from elbows, and hind limbs from knees, blackish brown, proximal portion like the body. Ears blackish

brown; proximal third of naked portion of tail blackish brown, apical two-thirds flesh-color or whitish. Facial markings reduced to a very narrow eyering; head as light as in *D. virginiana.*

Measurements. — Four males measure: Total length, 874 mm. (810–955); head and body, 452 (385–500); tail, 446 (425–465); hind foot, 60.5 (55–66); ear, 60 (55–65). Three females measure: Total length, 807 (740–850); head and body, 406 (350–468); tail, 401 (382–430); hind foot, 57 (55–58); ear, 53 (52–53). *Skull:* Three males, total length, 107 (101–110); basal length, 97 (91–101); length of nasals, 49 (47–50); zygomatic breadth, 63 (61–63.5); postorbital breadth, 22.3 (21–24); occipital breadth, 31.3 (30–32); breadth at canines, 19.7 (19–20); upper toothrow, 34.3 (33–36).

Specimens examined:

Trinidad: Princestown, Caparo and Caura, 10 specimens.

Island of Dominica: 3 specimens.

Island of Grenada, 2 specimens.

Island of St. Vincent, 2 specimens.

Total, 17 specimens,— 11 coll. Amer. Museum, 6 coll. Brit. Museum.

A series of ten specimens from various near-by localities in Trinidad (Princestown, Caura, and Caparo) are very uniform in coloration and other characters, and are readily distinguishable from true *marsupialis* from Guiana by their much lighter coloration and larger size. They vary chiefly among themselves in the color of the stiff overhair, which may be either white or black, or variously mixed in the same individual. St. Vincent, Grenada, and Dominica specimens are similar, and were most likely derived from the Trinidad stock, having doubtless been introduced into these islands from Trinidad.

Didelphis marsupialis colombica *Allen.*

Didelphis karkinophaga Bangs, Proc. N. Engl. Zoöl. Club, I, 89, Feb. 23, 1900. Santa Marta region, Colombia.

Didelphis karkinophaga colombica Allen, Bull. Am. Mus. Nat. Hist. XIII, 1900, 193, Oct. 23, 1900 (Santa Marta, Colombia); *ibid.* XIV, 1901, 186 (measurements).

Type locality, Santa Marta, Colombia.

Geographical Distribution. — Eastern Colombia, south to Bogota, and probably into northern Venezuela.

Similar to true *D. marsupialis* but larger, with smaller ears, and very much darker in coloration; head much darker with a tendency to indistinct median and eye stripes, the latter more distinctly developed behind the eyes; whole upper surface of head with a general blackish grizzled effect; ventral surface buffy, overlaid with a black-

ish grizzle produced by the longer black-tipped hairs; ears and feet wholly brownish black; basal half of naked portion of tail black, the rest yellowish white or flesh-color.

Measurements. — Five males, all from near Santa Marta, Colombia, measure: Total length, 822 mm. (710–980); head and body, 417 (355–456); tail, 405 (330–483); hind foot, 60 (57–68). Two females: Total length, 768 (673–863); head and body, 377 (318–406); tail, 406 (355–457); hind foot, 56 (54–57). *Skull:* 4 males, total length, 98 (94–107); basal length, 90 (85–99); nasals, 15 (14.5–16); zygomatic breadth, 52 (48.5–57); postorbital breadth, 21; postorbital constriction, 11.1 (10–12); occipital breadth, 29 (28–31); breadth at canines, 19 (16–21); upper toothrow, 35 (34–36); molar series, 19.4 (19–20).

Specimens examined:

Colombia: Santa Marta and vicinity, 8 specimens, coll. Amer. Museum. Also additional specimens in coll. H. H. Smith. Near Bogota, 2 specimens, coll. British Museum.

Total, 15 specimens.

This form, based originally on a series of 8 specimens from the immediate vicinity of Santa Marta, Colombia, is intermediate in size between *D. marsupialis* and *D. m. insularis*, being very much larger than the former and considerably smaller than the latter, with much smaller ears. It is very much darker in coloration than true *marsupialis*, which in turn is very much darker than *insularis*, with which latter comparison is unnecessary. As in the other forms of the *marsupialis* group, the long stiff overhair may be either all white, or the apical portion all black, or the two kinds of hair may be combined in various degrees of abundance in the same individuals.

Didelphis marsupialis caucæ *Allen.*

Didelphis karkinophaga caucæ Allen, Bull. Am. Mus. Nat. Hist. XIII, 1900, 192, Oct. 23, 1900 (Cali, Upper Cauca Valley, Colombia); *ibid.* XIV, 1901, 186 (measurements).

Type locality, Cali, Upper Cauca Valley, southwestern Colombia.

Geographical distribution. — Southwestern Colombia, east of the Western Cordillera.

Similar to *D. m. colombica*, but much darker throughout; a rather distinct blackish eyering, and often a well-defined median black stripe on the head, running from the nape forward, narrowing and terminating at a point on a line a little behind the eyes; rest of the head

dingy yellowish white, strongly washed with blackish; ventral surface buffy white, washed, often strongly, with blackish. Size and proportions about as in *colombica*, except that the ears are much larger.

Measurements. — Two adult males from the type locality measure, respectively: Total length, 770 and 740 mm.; head and body, 410 and 370; tail, 360 and 370; hind foot, 53 and 58. A female from the same locality measures: Total length, 740; head and body, 370; tail, 370; hind foot, 58. *Skull:* 4 adult male skulls from Cali measure as follows: Total length, 102.5 (94–107); basal length, 90.3 (85–99); nasals, 45 (42–50); zygomatic breadth, 52 (48.5–57); postorbital breadth, 20.5 (19–21); postorbital constriction, 11 (10–12); occipital breadth, 29.1 (28–31); breadth at canines, 19 (16–21); upper toothrow, 35 (34–36); molar series, 19.6 (19–20).

Specimens examined:

Colombia: 17 specimens, mostly immature, from Cali, Upper Cauca Valley; coll. Amer. Museum.

This subspecies is represented by 17 specimens, all from the vicinity of Cali, Cauca Valley, Colombia, of which 11 are adult and 6 immature. The immature specimens have the ears either wholly flesh-color (in the very young) or particolored, black at base and tipped more or less broadly with flesh-color, according to age. Unfortunately only a few of the specimens were measured in the flesh. The adults are mostly in the black phase, five being wholly black, two mostly black, and four gray; of the young, three are black and three gray.

Didelphis marsupialis etensis, subsp. nov.

? *Didelphis karkinophaga caucæ* Bangs, Amer. Nat. XXXV, 1901, 633. San Miguel Island, Panama.

Type, No. 18986 (formerly No. 0–3–1–86, Br. Mus.), ♂ ad., Eten, Piura, Peru (alt. 50 feet), Oct. 2, 1899; coll. P. O. Simons, No. 628.

Geographical Distribution. — The low coast-belt of Ecuador and Peru, bordering the Gulf of Guayaquil, and probably northward, near the coast, to Panama.

Similar in general coloration to *D. m. caucæ*, but larger and blacker. In fresh pelage the rostral region, as far back as the eyes, is dingy brownish white, the hairs being tipped with blackish; a whitish streak over each eye, the two meeting in front of the eyes; cheeks dingy whitish; middle of the head, from between the eyes posteriorly, blackish, the pelage whitish basally with long black tips; a blackish

eyering, continued both in front and behind the eyes as an ill-defined blackish spot; ears and feet black, as usual in the group; naked part of the tail black for the basal third, the rest yellowish white. Coloration in general as in all of the darker forms of the *marsupialis* group.

Measurements. — Four adult males from Eten measure as follows: Total length, 829 (730–930); head and body, 425 (390–480); tail, 399 (330–450); hind foot, 61 (56–67); ear, 56 (52–60). A female from the same locality measures: Total length, 769; head and body, 395; tail, 374; hind foot, 57; ear, 54. *Skull:* Six adult male skulls measure as follows: Total length, 110.5 (102–122); basal length, 102.4 (92–118); nasals, 53 (45–57.5); zygomatic breadth, 59.5 (58–64); postorbital breadth, 24.2 (23–28); postorbital constriction, 11.5 (11–12); occipital breadth, 33.8 (31–35.5); breadth at canines, 21.8 (19–25); upper toothrow, 35.5 (34.5–36); molar series, 19.4 (19–20).

Specimens examined:

Peru: Eten and Piura, Depart. of Piura, 8 specimens; coll. Brit. Museum.

Ecuador: Puna Island, 2 specimens; Guayaquil, 2 specimens; St. Javier, 1 specimen; Jambilar, 1 specimen; coll. Brit. Museum.

Colombia: Boqueron, Chiriqui, 33 specimens; Boquete, Chiriqui, 5 specimens; coll. Amer. Mus. and J. H. Batty.

Total, 52 specimens.

The above description is based on a series of 14 specimens, of which 7 are from Eten, Peru, two from Puna Island, and three from neighboring coast localities in Ecuador. In size they greatly exceed the series of *caucæ* from Cali, Colombia, and have the incipient face markings better defined. The tail about equals the head and body in length, as in that form. The total length of the animal, however, is about one eighth greater in *etensis* than in *caucæ*, and the length of the skull is also much greater—110.5 mm. as against 102.5 in *caucæ*. In size it approaches *D. m. richmondi* from Nicaragua, which, however, is not only much larger than *etensis* but has a relatively much longer tail, in *etensis* the length of the tail being a little less than that of head and body, and in *richmondi* considerably more than the head and body length.

A large series from the Department of Chiriqui, State of Panama, Colombia, is similar in size and proportions, and is not apparently distinguishable. This series includes 33 specimens from Boqueron, and 5 from Boquete, of which measure-

ments are given below (p. 277). These specimens are provisionally referred to *etensis*.

Didelphis marsupialis battyi *Thomas.*

Didelphis marsupialis battyi Thomas, Novit. Zool. IX, 137, April, 1902.

Type locality, Coiba Island, Panama, Colombia.

Geographical Distribution. — Coiba Island.

"Closely allied to *D. m. caucae* Allen, and agreeing with it in most details; but the face uniformly dark, with distinct white spots, about ½ in. in diameter, round the roots of the supraorbital and malar tufts of bristles. These white spots are clearly the remnants of the usual light frontal and cheek patches, the lower cheeks and lips being in the present animal no lighter than the rest of the head. No light dorsal bristles present in any of the specimens. Tail white for rather less than half its length, its basal fifth being like the body.

"Skull rather narrow, the muzzle long and the zygomata little expanded.

"Dimensions of the type, measured in the skin: Head and body 430 mm.; tail 390; white part of tail, 180; hind foot (wet), s.u. 57, c.u. 63; ear (wet), 50; skull, greatest length in middle line, 108; basal length, 100; greatest breadth, 52.5; combined length of three anterior upper molariform teeth, 18.4.

"*Type:* Old female. Original number, 106. Collected 6 May, 1901. Four specimens.

"The four specimens are all exactly similar in size and colour, and no doubt represent an insular form of the Colombian *D. m. caucae*."— Thomas, *l. c.*

Compared with a large series of specimens from the mainland, *D. m. battyi* seems to represent a small insular race, as shown by several topotypes kindly presented by the collector, Mr. J. H. Batty, to this Museum. I am also indebted to Mr. Batty's kindness for a transcript from his note-book of the measurements of the specimens taken before skinning. I am thus able to supplement Mr. Thomas's description with the flesh measurements of not only his type, but also of 7 additional specimens, given in the subjoined table (see p. 278). The four females, rather strangely, happen to range rather larger than the four males, doubtless owing to the fact that the females had reached a greater maturity than the males. If the females of the Coiba Island series and the females of the Boqueron and Boquete series be taken

as the basis of comparison, the apparent difference in size practically vanishes.

Didelphis marsupialis aurita (*Wied*).

Didelphys marsupialis Wied, Beitr. zu Naturg. Bras. II, 1826, 387 (not of Linnæus).

Didelphys aurita Wied, Beitr. zu Naturg. Bras. II, 1826, 393. "Villa Viçoza am Flusse Peruhype." Gray phase. — Burmeister, Thiere Bras. III, 1854, 130, gray phase; Erläut. zur Fauna Bras. 1856, 64, pl. iii, animal, pl. v, fig. 3 and pl. vi, fig. 1, skull (not the reference to *D. azaræ* Temminck, etc.). — Pelzeln, Verh. z.-b Gesell. Wien, XXXIII, Anh. 1883, 109, part; southern Brazil. — Goeldi, P. Z. S. 1894, 457. Serra dos Orgãos, Brazil.

Didelphis marsupialis aurita Cope, Am. Nat. Feb. 1889, 129, 149. São João do Monte Negro, Rio Grande do Sul.

Didelphys azaræ Wagner, Schreber's Säug. Suppl. III, 1843, 38 (mainly); *ibid.* V, 1855, 223 (part).

Didelphys cancrivora Burmeister, Thiere Bras. III, 1854, 129 = *D. marsupialis* Wied, (non Linn). Dark phase. — Hensel, Phys. Abhandl. Akad. Wiss. Berlin, 1872 (1873), 114, pl. i, figs. 2 and 5. Rio Grande do Sul. — Pelzeln, Verh. z.-b Gesell. Wien, XXXIII, Anh. 1883, 110 (Sapitiba). — Winge, Jordfunde og nulevende Pungdyr (Marsupialia) fra Lagoa Santa, etc., E. Museo Lundii, II, 1892, 8, pl. i, figs. 9, 9*b*; pl. iii, fig. 4; pl. iv, fig. 10.

Didelphys koseritzi Ihering, Mamm. do Rio Grande do Sul, 1892, 99 (p. 6 of separates). Black phase.

Type locality. — Villa Viçoza, Rio Peruhype, southeastern Brazil. Based on a single specimen, in the gray phase.

Geographical Distribution. — Southeastern Brazil, from Bahia (?) south to Rio Grande do Sul, and westward to Matto Grosso, Paraguay, northern Argentina, and eastern Bolivia.

Adult. — Dichromatic, with a gray phase and a black phase. An average adult in gray phase (Brit. Mus. No. 1–2–7–61, ♀ ad., Cruzeiro, alt. 530 m., San Paulo, Brazil, A. Robert, Nov. 14, 1900) may be described as follows:

Above soiled white, strongly varied with black; long overhair white to base, 80–100 mm. long on lower back; underfur clear yellowish white to base on middle of back, dirty yellowish brown at extreme base on sides, apical third to half black, coarser, almost bristly; below pelage much shorter and more woolly, brownish white basally, and tipped with blackish brown, with a sprinkling of yellowish white hairs; woolly hairs at edge of pouch dark brown or blackish chestnut; an indistinct spot of clear white on middle of chest; lower throat

more buffy yellow; chin and upper throat similar, but with the hairs tipped with dark brown, giving a darker effect. Head pattern quite well-defined, the light areas buff (not white) and the dark areas blackish or blackish brown. The central head stripe begins on a line opposite the front border of the eyes, and gradually widens posteriorly to the nape; the loral stripes begin about half-way between the nose and the eyes, and extend back, enclosing the eyes, nearly to the base of the ears, but less well defined and broader behind than in front of the eyes; sides of head below the ears buffy yellow. The head markings are generally indistinct in adults, well defined in young specimens and in exceptional adults. The light areas on each side of the median dark stripe form a distinctly lighter oval spot above and behind the posterior half of the eyes. Ears very large, *wholly black*. Fore and hind limbs black, including the toes, which (as usual in the genus) are semi-nude. Tail a little shorter than head and body, covered as usual at the extreme base by long hair like that of the adjoining part of the body, the rest naked, the basal half or more black, the remainder flesh-color.

This is the usual style, which varies on the dorsal surface to practically black, and to much darker below.[1] The light face markings are often nearly obsolete, being reduced to a dark buffy round spot over the eyes, with another on the posterior part of the cheeks. The underfur is often strongly yellowish white on the back and bright buff below, the extreme base being ochraceous buff, as in nearly all of the members of the *marsupialis* group, due apparently to a sebaceous secretion.

Young. — The nursing young are similar to the adults in coloration, both in the gray and black phases, except that the head markings are more pronounced, and the ears are white or flesh-color, more or less blotched with dusky, chiefly towards the base. In very young specimens the ears are doubtless wholly white to the base, as in the other members of the genus. In a series of 15 specimens from Piqueté and Cruziero, São Paulo (coll. A. Robert), the 9 adults have wholly black ears and the 6 young have particolored ears, the apical half or more being flesh-colored and the basal portion dusky or mottled with dusky. There is also rather less black at the base of the naked portion of the tail in the young than in the adult. The toes are wholly black in all, although Burmeister has described the toes as pinkish or flesh-color.

In the young (less than one-sixth grown) of this species the head markings are almost as distinct as in the young of corresponding age of *D. paraguayensis*, but the dark and light areas are less sharply contrasted, the light areas being buffy white instead of clear white, and the dark areas brown-black instead of deep black.

[1] Hensel (*l. c.*) states that of 40 individuals of which he had noted the color, 15 were black and 25 were white.

Measurements. — As shown in the subjoined table (p. 278), 3 adult males from Sãn Paulo measure: Total length, 778 mm. (745–806); head and body, 417 (405–426); tail, 349 (340–380); hind foot, 58 (48–61); ear, 48 (46–50). Six adult females average somewhat less. *Skull:* Total length, 7 males, 106 (96–109); basal length, 95.3 (94–100); nasals, 50.4 (47–54.5); zygomatic breadth, 55.5 (52.5–60); postorbital breadth, 23.4 (20–26.5); postorbital constriction, 11 (10–12); occipital breadth, 31 (30–32); breadth at canines, 19.7 (17.5–20.5); upper toothrow, 33 (31–36); molar series, 19 (18–20).

Specimens examined:

Brazil: Rio Rodeio, Serra do Mar, near Rio de Janeiro, 1 specimen; Rio de Janeiro, 1 specimen; Cruziero, São Paulo, 8 specimens; Piqueté, São Paulo, 7 specimens; Taquara, Rio Grande do Sul, 4 specimens, including paratypes of *D. koseritzi* Ihering; Rio Grande do Sul, 6 specimens.

Total, 27 specimens, coll. British Museum.

D. m. aurita of southern Brazil is smaller than true *marsupialis* of northern Brazil, much darker in coloration, and with much better-defined head markings. It more resembles the dark forms of northern and northwestern South America, but has the head markings more distinct and is very much smaller. In exceptionally strongly marked specimens the head markings sometimes approach in distinctness those of *D. paraguayensis*, but in such cases the light markings are deep buffy instead of clear white, and the dark areas are more brownish black and not nearly so sharply defined. Authors, however, have sometimes failed to distinguish these two very distinct forms, which seem to occur together over quite a large area.

Didelphis paraguayensis *Oken.*

Carigueya brasiliensibus, Marcgrave, Bras. 1648, 222 (*apud* Lund, *l.c.*).

Tai-ibi brasiliensibus, Marcgrave, Bras. 1648, 223.

Micouré premier, ou Micouré proprement dit, Azara, Quad. Parag. I, 1801, 244.

Did[elphys] paraguayensis Oken, Lehrb. der Naturg. Theil III, Abt. ii, 1816, 1147. Based primarily on Azara (*cf. antea*, p. 251).

Didelphis azaræ Temminck, Mon. Mamm., 2° Mon. 1825, 30.—Rengger, Naturg. Thiere Parag. 1830, 223. Grand Chaco and Provinces of Entre-Rios and Banda Oriental. — Martin, P. Z. S. 1834, 101, anatomy. — Thomas, Ann. and Mag. Nat. Hist. (7) VIII, Dec. 1901, 536. Rio Jordão, southwestern Minas Geraes.

Didelphys azaræ WATERHOUSE, Nat. Hist. Mamm. I, 1846, 470 (except ref. to *D. aurita* Wied). Brazil, Paraguay, Bolivia, etc. — BURMEISTER, Erläut. Faun. Bras. 1856, 61, pl. i, animal. — WAGNER, Schreber's Säug. Suppl. III, 1843, 38 (part); *ibid.* V, 1855, 223 (part). — HENSEL, Phys. Abhandl. Akad. Wiss. Berlin, 1872 (1873), III, pl. i, figs. 1 and 4. Rio Grande do Sul. — THOMAS, Ann. Mus. Civ. Stor. Nat. Genova, XX, 1900, — (p. 4 of separates). Province of Parana, Brazil.

Didelphys marsupialis azaræ COPE, Am. Nat. Feb. 1889, 129, 149. São João do Monte Negro, Rio Grande do Sul, and Chapada, Matto Grosso, Brazil.

Didelphis albiventris LUND, Kongl. Dansk. Vidensk. Selsk. Afhandl. VIII, 1841, 236. Lagoa Santa, Brazil. — BURMEISTER, Erläut. Faun. Bras. 1856, pl. ii, animal; pl. v, figs 4 and 5, and pl. vi, fig. 4, skull.

Didelphys pœcilotis WAGNER (ex Natterer, MS.) Arch. f. Naturg. 1842, i, 258, Cuyaba, Matto Grosso, Brazil; Abhandl. Akad. Wiss. München, V, 1847 (1850), 126; Schreber's Säug. Suppl. V, 1855, 219 (identified with *D. albiventris* Lund, of earlier date). — PELZELN, Verh. z.-b. Gesell. Wien, XXXIII, Anh. 1883, 109.

Didelphis leucotis WAGNER, Abhandl. Akad. Wiss. München, V, 1847 (1850), 127 (in text); Schreber's Säug. Suppl. V, 1855, 223 (Azara's Micouré premier renamed).

Didelphis pœcilonota SCHINZ, Syn. Mamm. I, 1844, 504. Rio Grande do Sul, Brazil.

Didelphys lechii IHERING, Mamm. do Rio Grande do Sul, 1892, 95 (p. 5 of separates) Dark phase, from south of the Rio Grande do Sul.

Didelphys marsupialis var. *albiventris* WINGE, Jordf. og nulev. Pungdyr (Marsupialia) fra Lagoa Santa, etc., E. Mus. Lundii, II, 7, pl. iii, fig. 3; pl. iv, fig. 9. Lagoa Santa.

Type locality, Asuncion, Paraguay.

Geographical Distribution. — Uruguay, northern Argentina, eastern Bolivia, and northward to central Matto Grosso, and Minas Geraes, Brazil.

Adult. — Above varied black and white, through the presence of a more or less abundant coat of long overhair, which is wholly clear white to the base in fresh pelage, soiled dingy white in old pelage; underfur clear white or yellowish white, the apical third deep black, the black-tipped portion very long and much coarser than the basal white portion, the pelage of the ventral surface having the character of woolly underfur tipped with black hairs, especially over the median area. The amount of white overhair above varies from being abundant, and forming a conspicuous feature of the pelage, to a scanty sprinkling or, in the black phase, its entire absence. Below the general color varies from nearly pure white to deep buff, with or

without black tips to the longer hairs. Face markings white and black, strongly contrasted and sharply defined; the V-shaped median black stripe begins about opposite the anterior corner of the eyes and runs back to the occiput, merging on the nape with the black-tipped underfur of the dorsal region. The lateral face marks begin at base of whiskers, midway between nose and eye, running back to enclose the eye, but terminating just behind it as a well-defined spot; sides of the head behind the eye-streak more or less suffused with dusky, forming an ill-defined band for about half the distance from eye to ear, produced by the tips of the hairs being tinged with blackish; a broad white band behind this dusky extension of the eye-streak joins the white of the cheeks with the broad supraloral white band. Ears apically white, the basal third more or less dusky but not black. Fore and hind limbs and basal half (or more) of tail black; the apical portion of tail white or very light flesh-color.

Young. — Similar to the adult, except that the eye-stripe runs posteriorly to the base of the ear, where it becomes somewhat expanded vertically.

Measurements. — An adult male, Goya, Argentina (R. Perrens): Total length, 673 mm.; head and body, 378; tail, 295; hind foot, 41; ear, 55. An adult female, Chaco, near Ascuncion, Argentina (Messrs. Swan): Total length, 653; head and body, 378; tail, 311; hind foot, 43; ear, 52. *Skull:* Old female, total length, 85; basal length, 77; zygomatic breadth, 43.5; length of nasals, 38; postorbital processes, 15.5; postorbital constriction, 9.6; occipital breadth, 26; breadth at canines, 15; upper toothrow, 29; molar series, 16. Another old female skull and an adult male skull, same locality, both more or less imperfect, present practically the same measurements.

An adult female from southern Minas Geraes (Rio Jordão, A. Robert) gives the following external measurements: Total length, 650; head and body, 360; tail, 290; hind foot, 40; ear, 53.

Specimens examined:

Argentina: Chaco, near Asuncion, 5; Tucuman, 1; Goya, 10, mostly half grown or younger.

Brazil: Lagoa Santa 1 (topotype of *D. albiventris* Lund); Rio Grande do Sul, 3 (including topotypes of *D. lechii* Ihering); Rio Jordão, southwestern Minas Geraes, 3.

Total, 23; coll. British Museum.

So far as the material at present available indicates, the south Brazilian animal may well be referred to true *paraguayensis*. Lund's *D. albiventris* was based on the light phase with a white belly, with which Wagner has himself identified his later-described *D. pœcilotis*. Wagner's *D. leucotis* is a new name for *D. azaræ* Rengger, which is the true *paraguayensis*.

Ihering's *D. lechii* was based on dark specimens from São Paulo.

The Chaco specimens are practically topotypes of Azara's Micouré premier, Azara's headquarters when he wrote his 'Quadrupeds du Paraguay' having been Asuncion, from which the Chaco localities are only about 50 to 70 miles distant. Goya is about 200 miles to the southward. The Chaco specimens are either wholly black, or have only a few scattered white hairs, while none of the Goya series is black.

Respecting the relative proportion of specimens of the two color phases, light and dark, it is of interest to note that Hensel (*l. c.*) states that of 57 specimens (the sexes equally represented), of which he noted the color, 11 were black, 45 white, and 1 intermediate; and that in a litter of 9 young found in the pouch of a white female, one was black, two had a few white hairs, and the rest were of the white phase. This affords conclusive evidence, if any were needed, that the dimorphism has no relation to sex or age.

There is little doubt that Temminck's name, *azaræ*, properly relates to this animal, which he identified with Azara's Micouré premier.[1] His description is pertinent to this in every respect except one, and not at all to the black-eared opossums of the *marsupialis* group. Throughout his description he reverses the color of the ears, as though writing from memory rather than with the specimens before him; describing them as yellowish at the base and all the rest black ("le plus souvent jaunâtres à la base seulement, et noires sur tout le reste"). Owing to this error Wagner (Abhandl. Akad. Wiss. München, V, 1847 [1850], 127) renamed Azara's Micouré premier *D. leucotis*, and applied the name *azaræ* to the black-eared species of southern Brazil, which Wied had named *D. aurita*. While it may be held that Temminck's name is clearly identified by his description as being applicable, as he intended it to be, to the animal described by Azara under the name Micouré premier, it is perhaps not an unmixed evil that an earlier name for the

[1] *Cf.* Thomas, Cat. Marsup. and Monotr., 1888, p. 328, footnote.

species is found in the *Didelphis paraguayensis* of Oken. (*Cf. antea*, p. 251.)

Didelphis paraguayensis pernigra (*Allen*).

Didelphis azaræ Tschudi, Fauna Peruana, I, 1844–1846, 143, 151 (part; not the description and only part of the references).

Didelphis pernigra Allen, Bull. Am. Mus. Nat. Hist. XIII, 191, Oct. 23, 1900; Inca Mines, Peru; *ibid.* 219; *ibid.* XIV, 1901, 41, 176, 186 (measurements). — Thomas, Ann. and Mag. Nat. Hist. (7) VII, Feb. 1901, 190 (southeastern Peru).

Type locality, Inca Mines, Department of Puno, on the upper Inambari River, southwestern Peru.

Geographical Distribution. — Central and southern Peru, into Bolivia. At the northward represented by a larger form, the *D. p. andina.*

Entire upper parts, except the head, intense shining black, the long thick overhair being wholly black, abundant, and not very stiff; basal half of the soft woolly underfur pale yellowish white, the tips black, the white basal portion wholly concealed by the thick, heavy coat of black overhair; head white, with three prominent, sharply defined black bands, one median and two lateral; the median stripe begins in a narrow point and rapidly expands posteriorly to the nape, where it merges with the black of the dorsal surface; the lateral stripe extends from the base of the whiskers to a little behind the eyes and then continues as an ill-defined dusky patch nearly to the ears; cheeks and throat rusty buff; rest of lower surface, except around the abdominal pouch, buffy white, the tips of the longer hairs black, giving a dusky tinge to the ventral surface; ears thickly haired for their basal half, *entirely white*, in striking contrast with the intense black of the whole upper surface of the body; feet black, the toes seminude; tail black for the basal two thirds of the naked portion, the rest white.

The young are similar in coloration to the adults.

Measurements. — Seven adults from Inca Mines, Peru, the type locality, seem to indicate very little sexual difference in size; the females average rather larger than the males, which may be due to their being obviously older, as shown by the skulls; yet the same is true of 9 other specimens from other localities as shown in the subjoined tables of measurements (see p. 279). *Skull:* For measurements of the skulls of the specimens from Inca Mines, see this Bulletin, XIV, 1901, p. 186. A series of 6 skulls from other localities agree in proportions, but range rather larger, the total length running from 91 to 102 mm., with the other measurements in proportion.

Specimens examined:

Peru: Inca Mines, altitude about 5000 feet, Depart. of Puno, 8 specimens, mostly 'young adults' (coll. Am. Mus.); Callao, altitude 60

feet, 4 specimens; Huacapistona and Perene, Depart. of Junin, altitude, 6000–7000 feet, 3 specimens; Limbona, Depart. of Puno, altitude 6700 feet, 1 specimen; Surco and San Mateo, Depart. of Lima, altitude 7000 to 9000 feet, 2 specimens; Carao, Depart. of Cajamarca, altitude 6000 to 7000 feet, 2 specimens (coll. Brit. Mus.).

Bolivia: Depart. of La Paz, altitude 4000–9000 feet, 3 specimens (coll. Brit. Mus.).

Total, 23 specimens, nearly all from altitudes above 5000 feet. All are in the wholly black phase except one.

D. paraguayensis pernigra differs from true *paraguayensis* in the greater extent of the black face markings, the median stripes beginning further forward, and the eye-stripes being broader and extending forward almost to the naked muzzle. The ears are, in the typical phase, entirely flesh-color; a few specimens from other localities, here referred to this form, show a tendency to dusky mottling at the base. The general size of the animal is rather larger, and the tail relatively longer than in *paraguayensis*, while the ears are smaller and much more hairy.

This appears to be the only form of *Didelphis* inhabiting central and southern Peru. Tschudi also mentions only one species of true *Didelphis* as occurring in Peru, which he says is found in all parts, but especially in western Peru. He speaks of it as reaching an altitude of 12,500 feet, but as being absent from the hot forest region, and rare on the eastern slope of the Coast Range at 6000 feet. His description of the species, however, is obviously compiled from Temminck and not based on Peruvian specimens, he even copying Temminck's erroneous description of the ears — "schwartz-braun, an der Basis smutzig weiss."

Didelphis paraguayensis andina, subsp. nov.

Didelphis azaræ Tomes, P. Z. S. 1860, 268. Cuenca, Ecuador.

Type, No. 99–12–7–6, British Museum, ♂ ad. Loja, Ecuador, June 2, 1899; coll. P. O. Simons; original number 352.

Geographical Distribution. — Andes of Ecuador, from 6000 feet to 12,000 feet altitude, and probably southward into northern Peru.

Gray phase. — Above varied black and white; long bristly overhair abundant, pure white; underfur white, very broadly tipped with intense black, involving about the apical third of the longer fibres;

below yellowish white, washed with grayish brown, due to the brown tipping of the longer hairs; limbs and feet wholly black, the former with a few scattered white hairs; head white with the dark markings very broad; the median stripe begins somewhat in front of the eyes and extends as a narrow band to the nape; the lateral stripe begins a little behind the eye, extends forward to the nose, and abruptly widens on the upper side, opposite the middle of the eye, so as to occupy nearly the whole of the side of the nose in front of the eye, where the two lateral stripes nearly meet, being separated by a light median space only about half as wide as the dark eye-stripe; the lower edge of the black eye-stripe forms a straight line running a few millimeters below the eye; immediately surrounding the eye and in front of it the dark stripe is intense black, but more anteriorly passes into brown-black, and immediately behind the eye quite disappears, leaving the space between the eye and ear dusky grayish white, through a slight dusky tipping to the hairs. The light area on the head begins on the nose as a narrow whitish band, dividing some distance in front of the eyes and passing, as a V-shaped mark on either side of the pointed median black band, back to the ears, spreading out laterally behind the eyes till it joins the white cheek-band, with, as already said, the tips of the hairs between the eyes and ears slightly obscured with dusky. The usual broad white cheek-band occupies the whole area below the eyes, from the nose to the side of the neck, which is superficially obscured with dusky, and often suffused basally with yellowish brown or gamboge. Ears hairy at the base, usually wholly light or flesh-color, but of a deeper, browner (not dusky) tint basally than apically; some specimens show dusky blotches basally. Tail black basally for about one third to one half the length of the naked portion, the rest light or flesh-color, but the relative extent of light and dark portions very variable.

Black phase. — Wholly without the long white overhairs, but otherwise similar to the gray phase. In the black phase the ears seem to show less tendency to dusky blotching at the base than in the gray phase.

The color of the ventral surface varies greatly in different individuals, in both phases. In some specimens the chin, throat, and breast are dull grayish or buffy white, while the rest of the ventral surface is superficially black, the whitish underfur showing only on parting the pelage. In other specimens the whole ventral surface is whitish, just as in the so-called *albiventris* phase of true *paraguayensis*.

Young. — Four very young specimens, in first pelage, from Cuenca, Ecuador, are dull black above profusely lined with white, the future white overhair; below thinly clothed with short hairs of a dull soiled white. Eye-stripe merely an oval ring enclosing the eye, its future extension, both anteriorly and posteriorly, outlined by a dusky tinge. Ears wholly flesh-color, very hairy on both surfaces.

Measurements. — The fine series of adults with measurements taken in the flesh by the late Mr. P. O. Simons include 7 specimens of each sex, which indicate the usual sexual difference in size found in the members of the genus *Didelphis*, and which doubtless obtains in all. (See subjoined tables of external measurements, p. 279.) The skulls belonging to these skins show that nearly all were middle-aged adults. The male skulls range in total length from 92 to 104 mm., and the females from 87 to 97, and thus considerably exceed in size specimens of corresponding age of the more southern *D. p. pernigra*.

Specimens examined:

Ecuador: Cañar, altitude 9000 feet, 3 specimens; Cayambe, altitude about 9000 feet, 1 specimen; Cuenca, altitude about 7500 feet, 4 specimens; Ibarra, altitude about 7500 feet, 2 specimens; Loja, altitude about 7000 feet, 2 specimens; Quito, altitude about 9500 feet, 5 specimens; Riobamba, altitude about 9000 to 12,000 feet, 5 specimens.

Total, 22 specimens, coll. British Museum.

This form differs from *pernigra* in being much larger, and in having the dark lateral head stripes much broader, especially in front of the eyes.

Didelphis paraguayensis meridensis, subsp. nov.

Type, No. 98–7–1–14, British Museum, ♂ juv., Merida, Venezuela, altitude about 6500 feet.

Geographical Distribution. — Eastern Cordillera of Colombia and Venezuela. The only localities represented are Bogota and Merida.

Black phase. — Long overhair black for apical two thirds, basal half white ; underfur pale yellowish white, broadly tipped with black; below pale yellowish white, the tips of the hairs pale grayish brown; median face stripe much shorter and narrower than in *pernigra* and *andina;* eye-stripes greatly reduced, narrow, and extending but little beyond the eye either in front or posteriorly, forming a small oval eye-spot, about three times longer than wide. Ears wholly pale yellow; limbs and feet black; tail black for the basal third, the rest pale yellow.

Gray phase (No. 42–4–12–20, Brit. Mus., Sta. Fé do Bogota, Colombia, ♂ juv.). — Similar in face markings and general coloration to the black phase, except that the bristly overhair is white instead of black.

This subspecies is based on the two specimens above described, neither of which is full-grown, nor are the skulls available for examination. It is strikingly different from the two Andean forms through the great reduction in extent of

the black face markings, which are even more restricted than in true *paraguayensis*. Although the material for examination is so scanty, it suffices to indicate a very distinct form, the geographical range of which appears to include the Eastern Cordillera region of Colombia and Venezuela. It is evidently cut off in its distribution from true *paraguayensis* of southern Brazil by the great Amazonian basin, where no form of this group appears to have been reported. Probably in southern Colombia its range connects with that of *D. p. andina*. In the character and extent of the head markings it, however, much more resembles the Argentina and south Brazilian type than it does either of the Andean forms.

Tables of the external measurements of the above described forms of *Didelphis* follow (pp. 276–279).

EXTERNAL MEASUREMENTS OF SPECIES AND SUBSPECIES OF DIDELPHIS.

	Mus. No.	Locality.	Sex.	Total length.	Head and body.	Tail.	Hind foot.	Ear.
Didelphis marsupialis marsupialis,[1]	1-6-4-125	Kanuka Mts., Br. Guiana,	♂	762	381	381	57	57
" " "	1-6-4-126	" "	♂	775	381	394	57	57
" " "	1-6-4-127	" "	♀	712	330	382	51	51
" " "	99-9-11-50	Mapures, Venezuela,	♀	776	357	419	54	52
		Average, 4 specimens		756	362	394	55.4	54
Didelphis marsupialis insularis,[2]	6061	Princestown, Trinidad, March 27, 1893	♂	810	385	425	55	—
" " "	6063	" " " 6, "	♂	920	455	465	66	—
" " "	7734	Caura, " April 6, 1894	♂	955	500	455	64	55
" " "	7740*	Capero, " March 26, "	♂	910	470	440	57	65
" " "	6062	Princestown, " " 9, 1893	♀	740	350	390	55	—
" " "	7732	Capero, " " 22, 1894	♀	830	400	430	57	52
" " "	7733	Caura, " April 9, "	♀	850	468	382	58	53
		Average, 4 ♂♂		874	452	446	60.5	60
		" 3 ♀♀		807	406	401	57	52.5
Didelphis marsupialis colombica,[2]	14613	Bonda, Santa Marta, Colombia, Jan. 19, 1899	♂	710	355	355	57	
" " "	15456	" " " " Aug. 5, "	♂	980	497	483	68	
" " "	15453*	" " " " April 19, "	♂	824	371	453	57	
" " "	14615	" " " " Jan. 14, "	♂	786	456	330	57	
" " "	14614	" " " " Dec. 20, 1898	♀	863	406	457	54	
" " "	15452	" " " " April 5, 1899	♀	812	406	406	57	
" " "	15455	" " " " July 24, "	♀	673	318	355	57	
		Average, 4 ♂♂		825	420	405	60	
		" 3 ♀♀		783	377	406	56	

[1] Specimens in British Museum.
[2] " " American "

* Type.

EXTERNAL MEASUREMENTS, ETC.—*Continued.*

	Mus. No.	Locality.	Sex.	Total length	Head and body.	Tail.	Hind foot.	Ear.
Didelphis marsupialis etensis,[1]	0–3–1–85	Eten, Piura, Peru,	♂	730	400	330	58	52
" " "	0–3–1–86	" " "	♂	850	430	420	64	58
" " "	0–3–1–87	" " "	♂	930	480	450	67	60
" " "	0–3–1–25	Piura, Piura, Peru,	♂	890	450	440	64	62
" " "	99–8–1–49	Guayaquil, Ecuador,	♂	785	390	395	56	53
" " "	99–8–1–18	Puna Island, "	♂	855	430	425	60	55
" " "	0–3–1–88	Eten, Piura, Peru,	♀	769	395	374	57	54
		Average, 6 ♂♂		840	430	410	61.5	56.6
Didelphis marsupialis etensis[2]	381	Boqueron, Chiriqui, Colom., Oct. 4, 1901	♂	880	450	430	70	45
" " "	750	" " " " 24, "	♂	820	380	440	65	53
" " "	904	" " " Nov. 8, "	♂	930	510	420	60	50
" " "	926	" " " " 13, "	♂	810	410	400	60	50
" " "	928	" " " " 16, "	♂	880	440	440	60	55
" " "	934	" " " " 16, "	♂	788	385	403	53	48
" " "	1004	" " " " 22, "	♂	910	470	440	60	55
" " "	1027	" " " " 26, "	♂	785	400	385	55	45
" " "	1062	" " " Dec. 2, "	♂	910	450	460	50	50
" " "	1080	" " " " 4, "	♂	950	510	440	65	50
" " "	338	" " " Oct. 4, "	♀	775	345	430	55	50
" " "	576	" " " " 10, "	♀	785	390	395	50	50
" " "	636	" " " " 13, "	♀	690	340	350	55	45
" " "	646	" " " " 15, "	♀	750	380	370	50	43
" " "	893	" " " Nov. 6, "	♀	860	430	430	60	50
" " "	932	" " " " 16, "	♀	780	400	380	55	50
" " "	984	" " " " 21, "	♀	845	410	435	50	45
" " "	996	" " " " 23, "	♀	810	410	400	60	50
" " "	1005	" " " " 22, "	♀	780	400	380	50	45
" " "	1050	" " " " 30, "	♀	930	500	430	60	55
" " "	223	Boquete, " " Aug. 23, "	♂	935	495	440	60	60
" " "	276	" " " Sept. 8, "	♂	835	455	380	70	55
" " "	187	" " " Aug. 19, "	♀	885	470	415	58	50
" " "	214	" " " " 22, "	♀	695	345	350	52.5	50
" " "	274	" " " Sept. 4, "	♀	745	360	385	55	
		Average, 10 ♂♂, from Boqueron		866	440			
		" 10 ♀♀ " "		805	405			

[1] Specimens in British Museum.
[2] Original No., coll. J. H. Batty.

EXTERNAL MEASUREMENTS, ETC.—*Continued.*

	Mus. No.	Locality.	Date.	Sex.	Total length.	Head and body.	Tail.	Hind foot.	Ear.
Didelphis marsupialis battyi,[1]	104	Coiba Island, Colombia,	April 15, 1901	♂	715	355	360	55	50
" " "	105	" " "	May 14, "	♂	845	430	415	60	50
" " "	107	" " "	" 17, "	♂	808	405	403	60	43
" " "	110	" " "	" 18, "	♂	815	425	390	53	50
" " "	103	" " "	April 11, "	♀	835	430	405	60	55
" " "	106*	" " "	May 14, "	♀	838	445	393	65	45
" " "	108	" " "	" 11, "	♀	820	425	395	60	55
" " "	109	" " "	" 18, "	♀	825	405	420	60	50
		Average, 4 ♂♂			796	404	392	57	48.2
		" 4 ♀♀			829.5	426	403	61	51
Didelphis marsupialis aurita,[2]	1-2-7-55	Piqueté, Sãn Paulo, Brazil,	Nov. 16, 1900	♂	806	426	380	61	50
" " "	1-2-7-57	" " "	Dec. 4, "	♂	745	405	340	54	46
" " "	1-2-7-56	" " "	Nov. 30, "	♂	782	420	362	48	48
" " "	1-6-6-89	Cruzeiro, " "	Feb. 7, 1901	♂ juv.	600	310	290	46	49
" " "	1-6-6-91	" " "	Jan. 27, "	♀	770	410	360	55	52
" " "	1-6-6-90	" " "	" 23, "	♀	—	410	—	61	51
" " "	1-2-7-60	Piqueté " "	Nov. 13, 1900	♀	770	410	360	58	60
" " "	1-2-7-62	" " "	Dec. 8, "	♀	750	410	340	53	52
" " "	1-2-7-61	" " "	Nov. 14, "	♀	678	358	320	41	39
" " "	92-5-9-1	Rio Rodeiro, Serra do Mar, Brazil,	Sept. 8, 1897	♀	753	365	388	55	55
		Average, 3 ♂♂ ad			778	417	394	54.7	48
		" 6 ♀♀ ad			744	410	354	54	51.5

[1] Original No., coll. J. H. Batty.
[2] Specimens in British Museum.

*Type.

EXTERNAL MEASUREMENTS, ETC.—*Continued.*

	Mus. No.	Locality.	Date.	Sex.	Total length.	Head and body.	Tail.	Hind foot.	Ear.
Didelphis paraguayensis pernigra,	16470 A.M.	Inca Mines, Dept. Puno, Peru,		♂	698	336	362	57	
" " "	16467 "	" " " " "	June 8, 1900	♂	635	305	330	57	
" " "	16471 "	" " " " "	" 22, "	♂	600	317	343	57	
" " "	16071 "	" " " " "	July 28, "	♀	749	381	368	63	
" " "	15798 "	" " " " "	Feb. 12, 1899	♀	811	443	368	60	
" " "	16469 "	" " " " "	July 22, 1900	♀	737	343	394	57	
" " "	16468 "	" " " " "	June 5, "	♀	660	300	360	57	
" " "	0-5-7-30 B.M	Callao, Peru,	Jan. 16, 1900	♂	653	320	333	52	46
" " "	0-6-6-37 "	Carao, Dept. Junin, Peru,	Dec. 10, 1899	♂	630	300	333	55	50
" " "	0-5-7-64 "	San Mateo, Dept. Lima, Peru,	Feb. 17, 1900	♂	755	400	355	55	50
" " "	0-5-7-31 "	Callao, Peru,	Jan. 10, 1900	♀	675	350	325	50	42
" " "	0-5-7-32 "	" "	" 12, "	♀	715	370	345	55	48
" " "	0-7-7-59 "	Huacapistona, Dept. Junin, Peru,	April 21, "	♀	630	320	310	48	47
" " "	1-1-1-55 "	Limbona, Dept. Puno,	July 6, 1901	♀	700	360	340	55	45
" " "	0-5-7-65 "	Surco, Dept. Lima, Peru,	Feb. 13, 1900	♀	770	430	340	52	51
		Average, 3 ♂♂, Inca Mines			644	319	345	57	—
		" 4 ♂♂, " "			739	367	372	59	—
		" 3 ♀♀, other localities			679	340	339	54	48.7
		" 5 ♀♀, " "			698	366	332	52	46.6
Didelphis paraguayensis andina,[1]	97-11-7-57	Ibarra, Ecuador,	May 25, 1897	♂	757	340	417	55	41
" " "	97-11-7-58	" "	June 31, "	♂	849	444	405	58	45
" " "	99-9-9-127	Riobamba, "	Feb. 14, 1899	♂	725	385	340	57	54
" " "	99-9-9-125	" "	Mar. 29, "	♂	810	410	400	60	50
" " "	99-9-9-126	" "	Jan. 18, "	♂	769	412	357	58	50
" " "	99-12-7-7	Loja, "	June 3, "	♂	725	360	365	55	48
" " "	99-12-7-6	" "	" 2, "	♂	764	430	334	60	55
" " "	98-2-18-24	Quito, "	Jan. 10, 1898	♀	746	396	350	55	49
" " "	99-12-7-8	Cuenca, "	May 8, 1899	♀	705	355	350	53	47
" " "	99-9-9-133	" "	" 1, "	♀	684	307	377	55	48
" " "	97-11-7-57	Cayambe, "	June 21, 1897	♀	678	348	330	50	40
" " "	99-9-9-128	Riobamba "	Jan. 20, 1899	♀	792	440	352	58	52
" " "	99-9-9-127	" "	" 18, "	♀	765	405	360	54	50
" " "	99-9-9-129	Cañar, "	" 18, "	♀	790	410	380	57	48
		Average, 7 ♂♂			771	397	374	57.6	—
		" 7 ♀♀			737	380	357	—	—

[1] Specimens in British Museum.

Article XXI.—NEW CANIDÆ FROM THE MIOCENE OF COLORADO.

By W. D. Matthew.

Cynarctus, new genus.

Family *Canidæ*, Subfamily *Amphicyoninæ*.

Dentition $\frac{3.1.4.3.}{}$. Carnassials reduced and molars enlarged, talonids bicuspid in the type species, and two accessory cusps on the trigonids. Jaw long and slender as in the dogs, premolars cynoid.

Cynarctus saxatilis, n. sp.

Size of the Coyote. *Jaw* somewhat more slender anteriorly, inferior border more convex, angular process longer, curving more upward and inward. Coronoid process more triangular, the tip narrow,

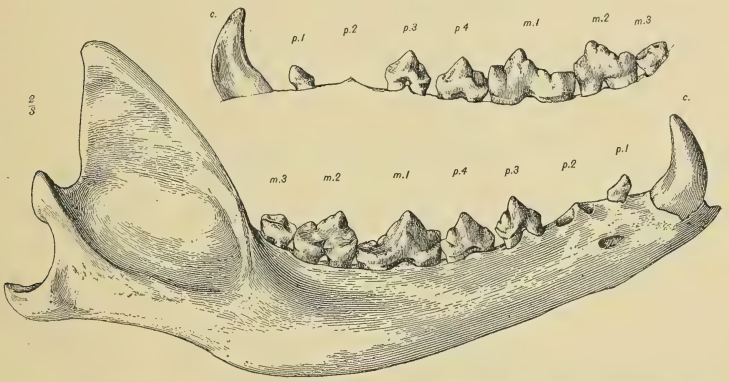


Fig. 1. *Cynarctus saxatilis*. Lower jaw, outer side, x ⅔, and inside view of teeth. Type, No. 9453. Loup Fork (Pawnee Creek Beds), Colorado.

the anterior border with slight uniform backward curvation, while in the coyote it is straight until near the tip and then curves suddenly backward. Masseteric fossa deeper and wider, its inferior border much more marked.

Teeth. Incisors not preserved. Canine and premolars little worn, molars much worn. Premolars somewhat smaller than in *C. latrans*, carnassial nearly one-fourth smaller, molars over one-fourth larger.

The trigonid of the *carnassial* is low, and reduced in size, and two

accessory cusps are added to it, one external to the protoconid, one behind the metaconid. The protoconid is central in position, greatly reduced in proportionate size compared with *Canis* or even with *Amphicyon*, and the shearing edges of pr^d and pa^d are reduced and little used. The accessory cusps and heel are nearly as high as the pa^d. The heel consists of a larger external and smaller internal cusp, both greatly worn, but apparently low and rounded. The external cingulum is strong and crenulate.

The second molar has the same composition as the first, except that the paraconid is small and connate with the protoconid, which is of the same size as the well-separated metaconid. The external cingulum is very broad in the anterior half of the tooth and bears one well-defined cusp external to the protoconid. The heel is nearly as long as the trigonid.

The third molar is obovate with shallow basin heel, and larger trigonid too much worn for distinction of cusps. The cusps of the heel are mostly obsolete, the surface wrinkled.

The premolars are shorter than in *C. latrans*, all except the first bearing the posterior accessory cusp, characteristic of the dogs, but absent in the bears. The first premolar is single rooted, spaced equally between the canine and second premolar. (In the dogs it approaches the other premolars, in the bears usually the canine.)

Canine slightly more slender than in *C. latrans*, more curved at base, less curved toward tip.

The deep masseteric fossa, long angular process, and strong metaconid suggest *Daphœnus*, which, however, has the normal canine proportion of carnassial and molar teeth, and, like all the more ancient genera, has the shear more oblique to the tooth-line than in the later Canidæ.

From the more ancient genus *Cephalogale* it differs in the presence of the accessory premolar cusps, slender jaw, larger molars, the posterior molars less unlike to the carnassial, and in the presence on the carnassial of two accessory cusps. All the modern microdont Canidæ except *Otocyon* have a more typical proportion of carnassial and tubercular teeth, and lack the accessory carnassial cusps. Their premolars are narrower. *Cynarctus* is near to *Haplocyon* Schlosser, founded on the jaw-fragment with pms 2 to 4 from St. Gérand-le-Puy, described by the late Prof. Filhol under the name of *Amphicyon crucians*. But the premolars are more cynoid, not so high, and the posterior accessory cusp is present on p_3. The

horizon of the two is different, and I hardly think that they are really allied, although the distinctions on known parts may appear rather slight.

From *Pseudarctos* it differs in the presence of the two accessory cusps on the trigonid of the carnassial, in the larger premolars with well-marked deuteroconid, the slender jaw and small third molar.

From *Amphicyon* the genus differs in the bicuspid heels of the molars, greater reduction of pr^4, and presence of accessory external and internal cusps, long slender jaw, and cynoid premolars.

From *Ursavus* it differs in the less reduction of the premolars, presence of accessory cusps on p_2, p_3, and p_4, and the much more cynoid character of molars 2 and 3. In *Ursavus*, judging from Dr. Schlosser's figures and description, the cusps on m_2 are nearly obsolete, and the surface flat and wrinkled, while m_3 is a round, peg-like tooth with flat, wrinkled crown. The jaw of *Ursavus* is deep and short like that of the bears, and the coronoid directed nearly upward as in the Ursidæ.

The foregoing description is based on a nearly perfect pair of lower jaws found in the Loup Fork (Pawnee Creek beds) of Cedar Creek, Colorado, by Mr. Brown of the American Museum Expedition of 1901. A single lower carnassial in the Cope Collection from the Colorado Loup Fork probably represents the same species. No upper teeth are known, and the position of the genus is therefore uncertain. Judging from the characters of the lower teeth it would seem probable that it must be placed with the Canidæ, and cannot be considered as near to *Ursavus*, which is unmistakably a bear. As far as can be determined from the lower jaw characters, it seems to be partly intermediate between *Ursavus* and *Canis*, with some primitive characters retained, no doubt, from its Oligocene ancestors. If this be borne out by the characters of the upper teeth, *Cynarctus* will help to bridge the most serious gap in the series of extinct genera connecting the Ursidæ and Canidæ. *Amphicyon*, as Dr. Schlosser has shown, does not fulfil the requirements for a direct ancestor of the

bears, but must be considered as a side branch paralleling them. *Cynarctus* would seem somewhat more but by no means exactly in the line of descent. The slender jaw excludes it from direct relationship.

In a previous paper the writer has discussed an alternate hypothesis of the origin of the Ursidæ which derives them from the Creodont family Arctocyonidæ, instead of from the Canidæ. It was then stated that the apparent chain of extinct types connecting the Canidæ and Ursidæ formed a most serious objection to considering any other hypothesis as possible, but it was pointed out that there was a wide gap in the series between such genera as *Amphicyon* and *Dinocyon*—unmistakable dogs although bear-like—and *Hyœnarctus* and *Ursavus*, unmistakable bears, although with the primitive carnivore formula lost by the modern bears. Dr. Schlosser has shown that *Amphicyon* is a side branch of the Canidæ and *Hyœnarctus* of the Ursidæ and that the wide gap between the primitive Oligocene dogs, such as *Cephalogale* and the earliest true Ursidæ cannot be filled by any genera hitherto known. The genus here described reduces this gap, as its close resemblance to *Ursavus* in the composition of the teeth seems hardly explicable except on the ground of a near relationship; while in most characters it is as unquestionably a dog as *Ursavus* is a bear. It does not seem, however, to point especially to *Cephalogale* as an ancestor. Its relationship to the direct line of descent is uncertain.

Nevertheless this additional evidence in favor of the derivation of the bears from early Canidæ seems to render untenable any other hypothesis. The Arctocyonidæ must then be considered as a case of parallelism not confined to the general characters of teeth and feet, but extending to the detailed structure of both, the rather exceptional cusp composition of carnassial and molar teeth, the relative proportions of the digits, even certain details in the character of the carpals and tarsals being common to both, besides the more general characters of large quadrate, flattened molars, reduced premolars, slender canines, plantigrade, large-clawed feet.

?? **Ursavus** sp.

Another small Amphicyonoid of about the same size as *C. saxatilis* is indicated by No. 9454, a lower carnassial, and a few fragments from Pawnee Buttes. The tooth is composed of very low trigonid of three cusps, paraconid nearly as large as protoconid, me^d well developed, more internal than posterior, long basin heel completely enclosed by a well-marked ridge, which begins at the metaconid and swings around the margin nearly to the protoconid, the heel-cusps being scarcely seen. Trigonid is proportioned much as in *Ursavus*, but no accessory cusps, and heel without well-marked cusps. Trigonid and especially the protoconid lower than in *Amphicyon*, and marked basin heel.

? **Cyon** or **Icticyon** sp.

A palate and a ramus of the lower jaw, both young individuals showing the milk dentition, are referred here. The permanent sectorials are formed within the jaw, but not extruded. The character of the milk dentition proves that the specimens belong to the Canidæ, but to the division of the family with most highly secant teeth. This is confirmed by the metaconid; in the superior one the deuterocone is minute, and there is no anteroexternal cusp. I am unable to make comparisons with the milk dentition of either *Cyon* or *Icticyon;* the permanent upper carnassials differ from the figures of *Icticyon* and from specimens of *Cyon alpinus* in the greater reduction of the anterointernal cusp and presence of two strong ridges on the anterior slope of the protocone, diverging from the point, one running to the anteroexternal corner of the base, the other to the base of the anterior internal cusp.

The permanent incisors are trifid, the lateral cusps being stronger than in any Canid that I have seen, equal almost to the median cusp. The external temporary incisor has but one strong lateral cusp, the external one minute; a posterior cusp is also present. The temporary canine is short and small with prominent posterior ridge. The permanent first premolar is one-rooted, with anterior and posterior cusps and

small posterior cingular cusp. The second temporary premolar is smaller, more compressed, two-rooted, with rudimentary posterior cusp. The third is the carnassial, and is three-rooted, composed of large protocone and strong posterior blade, with a minute anterointernal basal cusp situate between the anterior and internal roots. The fourth milk premolar is molariform, with no protoconule, strong hypocone (in reality probably a metaconule), besides the three main cusps. The second lower milk premolar is two-rooted, set obliquely in the jaw, and has a small posterior cusp. The fourth (carnassial) has the trigonid of shearing protoconid and paraconid blades, small metaconid, and three-cusped basin heel. Compared with the corresponding teeth in the Coyote these teeth differ in larger size, greater robustness, more sectorial character in the carnassials, proportionately smaller and narrower heel on dp_4, dp^4 of less transverse and greater longitudinal width, the inner cusps less marginal, reducing the size of the basin enclosed by them. The anterointernal cusp on dp^3 is smaller and situated much more anteriorly; the anteroexternal cingular cusp is hardly noticeable. The jaw is very much shorter and deeper, the premaxilla is carried much farther back between maxilla and nasal. The cusp composition is the same in both.

No Canid has been described with which this can well be identified. It is of the size of *Ælurodon*, but differs in absence of anteroexternal cusp on p^4 (and other characters). It is much more modernized than any of the John Day dogs, and the size is too great for *C. brachypus* Cope, *temerarius* or *vafer* Leidy, *anceps* Scott, all of which, moreover, seem more typically cynoid.

In a previous article Dr. Wortman and the writer attempted to trace a line of descent from the Eocene *Uintacyon* and *Prodaphœnus* through the Oligocene *Daphœnus* and *Temnocyon* to the modern *Cyon*. It seems not unlikely that the Canid here described may nearly represent the Upper Miocene stage of evolution of this race. *Icticyon* seems also to be more or less nearly connected with it—and if this hypothesis of descent be correct, this group parallels the Camels in their

present and past distribution, originating in North America, spreading to South America and Asia, and becoming extinct in their old home while still surviving in the two widely separated districts to which they had wandered.

In this as in other cases the writer desires to guard against expressing any belief that the evolutionary series worked out in various lines represent the actual species through which descent has occurred. They represent indeed the history of the evolution of certain parts; they may in some cases be not far from the direct line of descent. But it appears probable that each 'stage' represents in most cases a migration rather than a mutation of species. Believing that the principal causes of the evolutionary changes among the Tertiary mammalia lay in the secular world-wide alteration in climatic and geographic conditions, it seems improbable that in any given locality a change in the fauna occurred directly without a change in the area over which the species flourished. It seems much more likely that most of the changes in fauna in a locality were due to successive waves of migration, setting out from the region in which the new climatic conditions first appeared. This would involve in general a succession of waves of migration spreading from the north into America on one hand, Europe, southern Asia, and Africa on the other, differentiating to some extent as the separation increased, and driving the older faunas southward before them. Hence the Tertiary aspect of so large a part of the South American and African faunas, and hence the primitive aspect of forest faunas in general, the new conditions of cold and arid climate which culminated in the Glacial Epoch involving the spread of open plains, and diminution of the forest areas.

Amphicyon americanus *Wortman.*

Amphicyon americanus WORTMAN, Amer. Journ. Sci., Vol. XI, 201, Sep. Jan. 25, March, 1901.

This species is of moderate size in the genus and of rather primitive character, in some respects approaching the species of the European Oligocene (*A. lemanensis*, etc.). Dr. Wortman gives the following measurements:

Length of superior molar series, including canine...	134 mm.
Anteroposterior diameter of canine at base.....	24
Length of true molar series.....	46
Transverse diameter of first superior molar.....	27
Anteroposterior diameter of superior sectorial.....	27
Width of palate at first molar, including crowns...	98

Amphicyon sinapius, n. sp.

? *Canis, sp. incerta,* Cope, Rep. Vert. Pal. Col. U. S. G. S. Terrs. Ann. Rep. 1873 (1874), 519.

A larger American species of *Amphicyon* is represented by a number of fragmentary specimens from the Colorado Loup Fork.

Am. Mus. No. 9358. Jaw fragment with broken carnassial and complete first tubercular molar. Type.
" 9357. Carnassial tooth, unworn. Co-type.
" ?9356. Twenty-three vertebræ, ribs, humerus, and ulna.
" ?9355. Astragalus, parts of tibia, humerus, radius, and several metapodials, of uncertain association.
" ?8248. (Cope Coll.). Astragalus, and anterior part of a lower jaw, without teeth.

Our material unfortunately does not enable us to determine the dental formula, but the characters of the teeth agree best with those of *Amphicyon*, and are more primitive than those of *Dinocyon*. It is much larger than *A. lemanensis*, but resembles rather nearly the figures of that genus given by Dr. Schlosser. It somewhat exceeds *A. major* and *A. giganteus* in size, the heel of m_1 is broader, m^2 is much larger and broader comparing it with de Blainville's figures, and on both molars the entoconid is represented only by a broad cingular ridge. Both in size

Fig. 2. *Amphicyon sinapius.* Part of lower jaw, inner side, x ⅔. Type, No. 9358. Loup Fork (Pawnee Creek Beds), Colorado.

and characters the second lower molar is very like that figured by Dr. Schlosser in 'Palæontographica' and referred

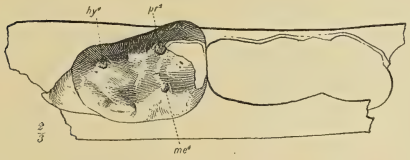


Fig. 3. *Amphicyon sinapius.* Crown view of m_1 in jaw, x ⅔. Type, No. 9358.

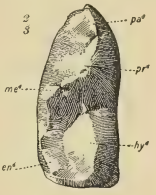


Fig. 4. *Amphicyon sinapius.* Lower carnassial x. ⅔ No. 9357. Loup Fork (Pawnee Creek Beds), Colorado.

doubtfully to *A. major.* Without more complete material the position of this species cannot certainly be determined.

? Dinocyon (Borophagus) mæandrinus (*Hatcher*).

Ælurodon mœandrinus HATCHER, Amer. Nat. 1893, 240.

The type consists of part of a lower jaw, with the second and third premolars greatly worn, and roots of fourth premolar and sectorial. It differs from other Ælurodons, according to Mr. Hatcher's description and figure, in the much greater size, extremely short jaw, and reduced premolars, large posterior root to the sectorial. All these characters point to the Amphicyoninæ rather than to the true dogs; the second molar, whose proportionate size would make the position of the species certain, is unfortunately not indicated in the type.

To this species may be referred provisionally Am. Mus. No. 10583, a fragmentary lower jaw with roots of the teeth, associated with parts of tibia, etc., found by Mr. Gidley of the American Museum Expedition of 1899 in the Loup Fork formation of Donley Co., Texas.

Measurements.

	Type.	*10583*
Post-canine diastema	19	14
Premolar dentition	60	62
Carnassial, length	47	47
Second molar	—	24
Carnassial, width ant. root	—	15
" " post. "	—	20
Depth of jaw behind p_4	55	69

? Dinocyon (Borophagus) diversidens (*Cope*).

Borophagus diversidens Cope, Amer. Nat., 1892, 1028; Vert. Pal. Llano Estac. (4th Ann. Rep. Geol. Surv. Tex., 1892), 54, pl. xiii, fig. 4.

Blanco horizon (Upper Pliocene). Referred to the Hyænidæ by Professor Cope. The type is a fragment of a lower jaw, with two premolars preserved and the root of a third. It agrees with *Amphicyon* more nearly than with *Hyæna* in the form of the individual teeth, as well as in their proportion one to another; the second premolar is smaller, apparently, than in the Loup Fork species.

? Dinocyon (? Borophagus) gidleyi *Matthew.*

Dinocyon (? *Borophagus*) *gidleyi* Matthew, Bull. Am. Mus. Nat. Hist., Vol. XVI, 1902, 129–136.

? Amphicyon ursinus *Cope.*

Canis ursinus Cope, Proc. Phila. Acad. Nat. Sci. 1875, 275; Rep. Wheeler Survey, Vol. IV, pl. ii, p. 304, pl. lxix, fig. 1.

The reduction of the premolars, proportionately large tubercular teeth, deep, massive jaw with comparatively straight inferior margin, large heel on the lower sectorial, etc., place this species with the Amphicyons. Professor Cope remarks on the probability that *C. ursinus* is very close to *C. haydeni.* Leidy's species is, however, much more like the wolf in proportion of sectorial to tubercular teeth, and the heel of the sectorial is comparatively small, as in *C. lupus* or in the Ælurodons.

A. ursinus is about the size of *A. americanus*, and is perhaps synonymous with it.

Article XXII.—A HORNED RODENT FROM THE COLORADO MIOCENE. WITH A REVISION OF THE MYLAGAULI, BEAVERS, AND HARES OF THE AMERICAN TERTIARY.

By W. D. Matthew.

Ceratogaulus rhinocerus, n. g. et sp.

The writer has recently described part of the skull of a *Mylagaulus* from the Colorado Loup Fork beds, found in 1898. A nearly complete skull, with one ramus of the lower jaw, found by Mr. Brown of the Expedition of 1901, indicates a new genus of this family, distinguished by the unique character (for a rodent) of a pair of large connate processes on the nasals resembling the horn-cores of some Ungulata, and giving the skull a profile absurdly like that of a miniature rhinoceros.

The skull is a little larger than that of *Mylagaulus*, and displays considerable modifications, chiefly conditioned by the development of the horn-like processes on the nasals. The muzzle is much wider and tapers forward; the nasals are much wider throughout, and especially in the middle, where they bear the horn-cores. The postorbital processes of the frontal and jugal bones are considerably less prominent and placed farther back, making the orbit larger and more extended anteroposteriorly. The zygomata are deeper. The enlarged molar in the upper jaw differs a little in form, and considerably in the pattern of the crown. The penultimate upper molar appears to be considerably larger in proportion, but is so much damaged in the *Mylagaulus* skull that it cannot be closely compared. The enlarged molar of the lower jaw displays a crown pattern with the usual lakes in three longitudinal rows, instead of four as in *Mylagaulus*. The alveoli of the second and third molars are of nearly equal size, while in *Mylagaulus* the penultimate alveolus is much larger. The type specimen No. 9456, is of nearly the same age as the *Mylagaulus* skull with which it has been compared, the wear of

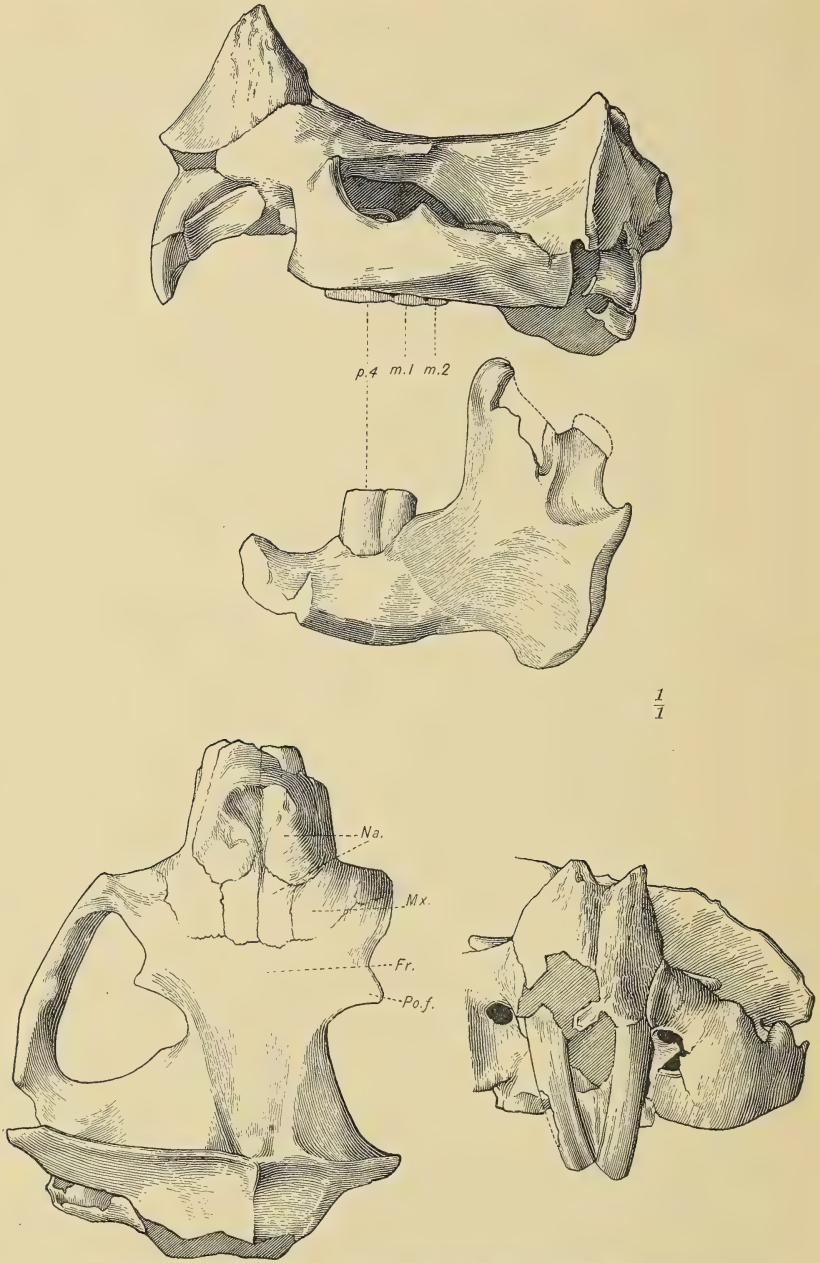


Fig. 1. *Ceratogaulus rhinocerus.* Skull and jaw, natural size. Superior, lateral and anterior views. No. 9456 (type). Loup Fork, (Pawnee Creek Beds) Colorado.

the teeth being slightly less advanced. The distinctions, therefore, cannot be due to age. The horn-like processes might be sexual, although I can find no parallel among the rodents for such a wide divergence between male and female; but the marked distinctions in the teeth and other characters are not likely to be sexual, although in themselves they are not of generic importance.

The height of the horn-cores is about one-fifth the length of the skull, their length a little more, and their conjoined width about one-fourth the skull-length. The longer axis of each process is diagonal, posteroexternal and anterointernal; the conjoined process is subtrigonal, the angles posteroexternal and anterior.

A character so marked as this would seem a good basis for a separate genus. Nevertheless, the resemblance to the skull of *Mylagaulus* obtained in 1898 is considerable in most characters, except in the horn-cores, the position of the postorbital processes, and the pattern of the enlarged grinding teeth.

The occiput is extraordinarily wide and low, its width equalling the entire length of the skull. The postorbital crests do not unite behind; the top of the skull is flat transversely, concave anteroposteriorly, and the occipital surface slopes 30° forward from the condyles to the top of the crest. The zygomatic arches are stout, deepest in front, somewhat wider than the occiput, both postorbital processes (on the frontal and jugal) moderately strong. In both upper and lower jaws the alveoli of two smaller molars are preserved, but no clear indication of a third, behind the enlarged tooth.

Measurements.

Length of skull (condyle estimated)	68 mm.
Width across arches	64
" of occiput	65
Height of horn-core	13
Length " "	17
Conjoined width of horn-cores	19
Width across postorbital processes of frontals	32
Width across postorbital constriction	18
Least depth of zygomatic arch beneath orbit	9

Length of diastema	20 mm.
" " three upper molars (? p^4–m^2)	15
" " enlarged " molar (? p^4)	8
Width of " " " "	6.5
Height of same (root and crown)	12
Estimated length of lower jaw	58
Depth of jaw beneath molars	15
Height " " (angle to tip of coronoid process)	41
Length of enlarged lower molar (? p_4)	10
Width of " " " "	5.5

This remarkable skull has no parallel among the Rodentia. *Haplodontia* most nearly approaches it in width, but the horn-cores and the specialized teeth are unique.

HIND LIMB AND FEET OF MYLAGAULIDÆ.

We know but little as yet of the skeleton of this family. The pelvis was very massive, and beaver-like on a smaller scale, the tail probably not flattened, and the scaphoid and lunar were united. A metacarpal associated with two teeth of *Mylagaulus* shows some remarkable characters. It is nearly as large as the metacarpals of *Castor canadensis* and much stouter. The distal facet is strongly keeled on the inferior surface, in a manner recalling the distal ends of metapodials of *Chalicotherium* or metacarpals of *Dasypus*. The facet is limited superiorly, so that it is not at all reflexed over the superior surface of the metacarpal, but faces entirely inferiorly and distally. The characters of the bone may be taken to indicate the presence of large digging claws on the manus.

I refer also to this family a remarkable specimen in the Cope Collection from the Loup Fork beds of the Republican River, Nebraska, consisting of a nearly complete hind limb and foot, with an ungual phalanx of the fore foot, not associated with any parts of the skull. This specimen combines characters of a Castoromorph rodent, with a resemblance to the modern armadillo so striking that I am unable to state positively that it is not edentate.[1] As nearly as I can judge, however, the ar-

[1] Professor W. B. Scott, whose recent extensive and thorough studies of the Santa Cruzian fauna give especial weight to his authority, has examined this specimen and pronounces it probably rodent and certainly not edentate.

madillo resemblances may be explained as all associated with the development of digging claws, chiefly on the fore foot, and walking on one side of the foot in consequence. The Castoromorph characters, on the other hand, appear to be such as would indicate real relationship, although not close relationship to any living form. From the phalanx just described we have reason to infer that *Mylagaulus* developed large digging claws on the fore foot, and this specimen is of appropriate size and proportions to belong to the *Mylagaulus*. It is found in the same horizon, and could not belong to any other rodent known from those beds, for all the others are quite nearly allied to still existing genera. Edentates have not been found in the Loup Fork,[1] and our specimen shows no resemblance to

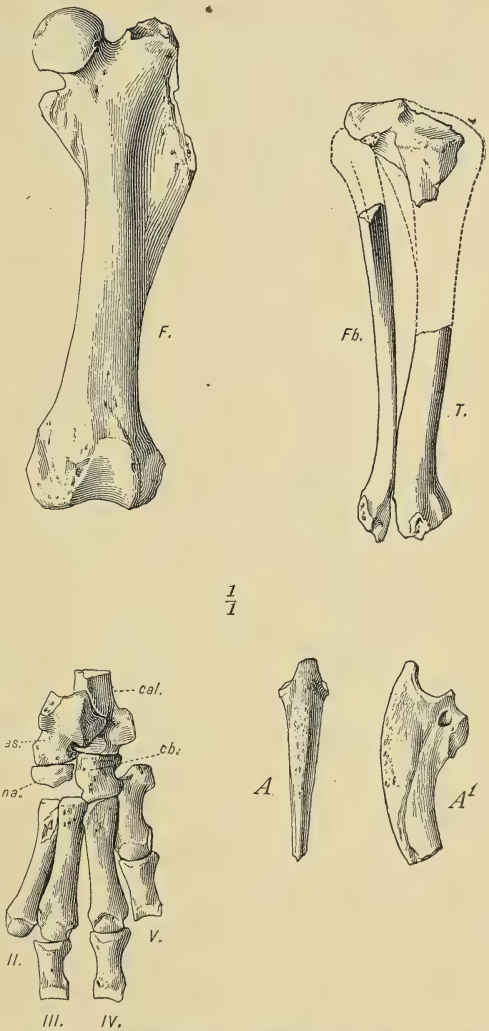


Fig. 2. Mylagaulid, indet. Hind limb bones and claw, natural size: *F*, anterior view of femur; *Fb*. *T*. posterior view of tibia and fibula; superior view of pes; *A*, *A*,[1] superior and lateral views of ungual phalange of fore foot. No. 8336. Loup Fork, (Republican R. Beds) Kansas.

[1] The supposed exception, *Caryoderma snovianum*, is, according to Williston, a turtle.

any known fossil edentate, the resemblance being only to *Dasypus*, and to a much less extent to *Tatusia*. From this it seems reasonably safe to infer that it is a Mylagaulid, and that this family paralleled the Armadillos in the structure of their feet.

The *femur* (Fig. 2, *F*) is nearly complete; it differs from either beavers or armadillos in the position of the very large and powerful third trochanter, which is placed high up on the shaft, nearly opposite the second trochanter, instead of in the middle of the shaft as is usually the case. The greater and lesser trochanter are much as in *Castor;* the distal condyles are wide and low, and the trochlea short, broad, and shallow.

Most of the *tibia* and *fibula* (Fig. 2, *Fb.*, *T.*) are preserved; the tibia is short and stout, beaver-like at the lower end; the fibula as strong as in *Castor*, separate from the tibia, with a vertical internal facet for the astragalus, but no distal facet, and no contact with the calcaneum. The astragalus (Fig. 2), is quite rodent-like, with moderately broad trochlea defined by sharp keels internally and externally, rather small neck, and broad, flattened head. Metatarsals II to V are present, but the hallux was rudimentary or absent. The second metatarsal is much more slender than the third and fourth, but of about the same length. Mt. V is only three-fifths as long as the others, but fully as stout as mt. III and IV. The phalanges of the first row are rather short, their distal facets wide, not deep, moderately concave from side to side. The size and strength of the metatarsals and proximal phalanges does not appear adequate to bear the very large claw (Fig. 2, *A*, A^1) with which they are associated, and I therefore suppose that it belongs to the fore foot, where the much stouter and more specialized metacarpal, such as has been described as occurring with teeth of *Mylagaulus*, could very ap-

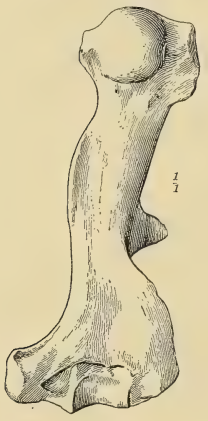


Fig. 3. Humerus of ? *Ceratogaulus*, natural size. No. 9457. Loup Fork (Pawnee Creek Beds), Colorado.

propriately bear it. This claw phalange is long, compressed, the proximal facet very little keeled, the distal end slightly fissured but not symmetrically so, and shows no hood at the base.

The hind foot when set in position on wax shows an unmistakable twist, the external side being bent down distally as if the animal walked on the outside edge of the foot, turning the claws inward underneath. This may serve to explain the short, stout fifth digit, as contrasted with the long, slender second; a proportion seen also in the armadillo and some other modern Edentates.

REVISION OF THE SPECIES.

On comparing the two skulls and three other more fragmentary specimens from Colorado with five specimens of *Mylagauli* from Nebraska in the Cope Collection, it appears that a considerable number of species are represented. On reviewing the description of *Mesogaulus ballensis* Riggs I find that I was in error in identifying it with *Mylagaulus monodon*, but its position can hardly be determined until more is known of the milk dentition and the history of the changes in tooth pattern in this curious family. As far as at present determinable the characters of the known species are:

Mylagaulus monodon *Cope.* Type, a jaw with the enlarged molar and two alveoli posterior to it, from the Loup Fork of the Republican River Valley. A second specimen, a lower tooth from the same locality, referred to it by Professor Cope, is considerably larger. Enamel lakes in four rows. There are seven lakes in the type; nine in the associated specimen. No cement outside external enamel ring.

	No. 8327 (type).	No. 8328
Extreme anteroposterior diam. of molar	?	11.5 mm.	13.5 mm.
transverse " " "	——	6.5
Anteroposterior diam. of grinding surface	10.5	11
Transverse " " " "	6	6

Mylagaulus sesquipedalis *Cope.* Type, an upper molar, No. 8329. Referred specimen a lower molar and incisor and a metacarpal, No. 8330. Both from the same locality as *M.*

monodon. They are much smaller, and the pattern of the enamel lakes simpler and more irregular. Those of the lower tooth are six in number, corresponding in position to the lakes in *M. monodon*, but less elongated, fewer in number, and less regularly arranged. Grinding surface of upper molar regularly oval, with six lakes irregularly arranged.

	No. 8329 (type).	No. 8330
Upper molar, extreme anteroposterior diameter..	10 mm.	
" " transverse.....	5.5	
" anteroposterior diam. of grinding surface.....	8	
" transverse diam. of grinding surface.	5.5	
Lower molar, anteroposterior diam. (estimated)..		8.5
" transverse "		4.5

Mylagaulus (Mesogaulus) ballensis *Riggs.* Type, a lower jaw containing three teeth, from the Deep River beds of Montana. Size of *M. sesquipedalis*, but with only four enamel lakes and, according to Mr. Riggs's drawing, a heavy band of cement surrounding the grinder. Our specimens show nothing like this; several have a thin layer of cement over parts of the outside, but never at the grinding surface, except in a supposed milk-tooth in which the enamel ring does not come up to the grinding surface.

Dimensions, from Riggs's Description.

Anteroposterior diameter of grinder.....	9 mm.
Greatest lateral breadth of "	4.2

Mylagaulus lævis, n. sp.

M. monodon MATTHEW, Mem. Am. Mus. Nat. Hist. I, 1901, 377. Not *M. monodon* Cope.

Type, front half of skull and jaw, pelvis, and other fragments from the Loup Fork of Colorado. Smaller and less robust than *M. monodon*, pattern of lower molar similar, with seven lakes arranged in four rows. Upper molar flattened externally, not regularly oval like that of *M. sesquipedalis*, lakes longer, narrower, and lying more regularly parallel. Nasals smooth.

Dimensions.

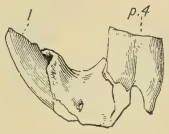
Lower jaw, diameter of enlarged molar, anteroposterior (grinding surface)	9 mm.
Lower jaw, diameter of enlarged molar, transverse (grinding surface)	5
Upper jaw, diam. of enlarged molar, anteroposterior (grinding surface)	9
Upper jaw, diam. of enlarged molar, transverse (grinding surface)	5.8

Ceratogaulus rhinocerus, n. sp.

Generic characters: Nasals bearing a large pair of horn-like processes, closely twinned. *Specific characters:* Size somewhat larger than that of *M. lævis*, less than that of *M. monodon*. Enamel lakes of lower molar simpler, seven in number, arranged in three rows, less regular than those in *M. monodon* or *M. lævis*. Alveoli of last two molars of subequal size. External side of upper grinder flat, internal strongly convex. Second upper grinder larger than third. Muzzle broader than in *M. lævis*, postorbital processes shorter and more posterior.

Dimensions of the Enlarged Grinders.

	Upper.	Lower.
Anteroposterior diameter.	8.7 mm.	9.7mm.
Transverse "	6.5	5.5



Mylagaulus paniensis, n. sp.

A small and simple species indicated by half a lower jaw and a few fragments. There are five enamel lakes, of which the three interior ones are arranged in a row as in *M. ballensis;* and external to these are a large and a small lake, the latter corresponding to the fourth lake of *ballensis*. The tooth is worn well down, while that of *ballensis* appears to be a comparatively young individual, so that the less number of lakes in Mr. Riggs's species can hardly be due to greater age; and on

Fig. 4. *Mylagaulus paniensis*, part of lower jaw. No. 9361 (type) Loup Fork (Pawnee Creek Beds), Colorado.

our specimen is no trace of external cement. This specimen comes from the base of the Loup Fork beds at Courthouse Butte, near Pawnee Buttes, Colorado.

Dimensions, No. 9361.

Anteroposterior diameter of lower molar	7.4 mm.
Transverse " " " "	4
Length of diastema	7
Transverse width of incisor	3
Anteroposterior diameter of incisor	4

CASTORIDÆ.

Steneofiber *Geoffroy.*

The pattern of the molars in this genus is so evanescent that it is almost impossible to make satisfactory comparisons of species on the limited number of specimens available. The essential pattern of the upper teeth consists of a deep internal enamel inflection and three external ones, the anterior and posterior of which quickly become fossettes. In the lower teeth the pattern consists of a simple external and three internal inflections, the anterior and posterior internal inflections soon becoming fossettes. With moderate wear the crown is divided transversely, by the internal and external inflections, into an anterior and a posterior column, united at the base, each column containing a fossette, sometimes more than one. The teeth become broader transversely with wear, and much less in their anteroposterior diameter; the anterior column increases and the posterior one diminishes in size in the upper teeth, while the converse holds true in the lower teeth. The enamel folds become closer, and their direction changes with wear; the internal one in the upper teeth, the external one in the lower, becoming more nearly anteroposterior in direction. The principal inflections in old individuals have become fossettes, while the minor inflections have disappeared. The last molar in young individuals appears small in proportion, because of the small area of the grinding surface; in older individuals it appears larger in proportion. The fourth premolar of

young individuals likewise appears small in proportion to the first and second molars, but reaches its maximum of size earlier than does the third molar.

These observations are based on the American species, which are a rather closely allied group, characteristic of the Oligocene, and more primitive than the European assemblage of species, which are characteristic of the Miocene epoch, and in general larger, longer-toothed, and nearer to the modern branches. The *S. viciacensis* of the Upper Oligocene (St. Gérand-le-Puy) appears to be the nearest to the American group. The distinctions between our species have been based, unfortunately, chiefly on the evanescent pattern of the teeth, not sufficiently considering the great alteration due to a comparatively slight difference in their wear. Seven species have been described, as follows:

1. *S. nebrascensis* Leidy. White River, S. Dakota, skull and jaws.
2. *S. pansus* Cope. Loup Fork, N. Mexico, upper and lower jaws, etc.
3. *S. peninsulatus* Cope. John Day, Oregon, skull.
4. *S. gradatus* Cope. John Day, Oregon, skull.
5. *S. montanus* Scott. White River, Montana, teeth and skeleton fragments.
6. *S. hesperus* Douglas. White River, Montana, lower jaw.
7. *S. complexus* Douglas. White River, Montana, part of skull and jaws.

I have at hand for comparison the types of all the species except the first two, besides three other skulls and some less complete material. I am indebted to the courtesy of Professor Scott and Mr. Douglas for the loan of the type specimens of the species described by them. In revising these species it has been necessary to reject a large part of the distinctions made by their authors, as being merely a matter of different age in the type specimens.

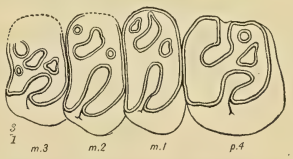


Fig. 5. *Steneofiber nebrascensis.* Upper molars x $\frac{2}{3}$. No. 1428. White River (Protoceras Beds), South Dakota.

1. **S. nebrascensis.** I refer here a skull, No. 1428, which, like Leidy's type, comes from the Protoceras beds, and part of a lower jaw, No. 1028*b*, in our

collections. The former is an older animal than Leidy's type, the latter younger. The species appears to be distinguishable by the long, narrow muzzle, small bullæ, sharp sagittal crest, and small brain-case. The postorbital constriction is moderate, the pattern of the teeth rather complicated, two deep fossettes anterior to the external inflection on p^4 remaining in the well-worn teeth of No. 1428.

2. **S. peninsulatus.** Besides the type skull, another skull, less crushed, a skull and jaws, and several parts of jaws, etc., referable to this species, are in the Cope Collection in this museum. It is a more robust species than the last, distinguishable by the large bullæ and probably by the broader muzzle, wide occiput, larger brain-case, and wider sagittal crest. The postorbital constriction is very narrow in the type, but not in the second specimen. The teeth are much like those of *S. nebrascensis*, but the second anterior fossette of p^4 apparently remains longer as a branch from the medial external enamel inflection. The fossette remaining from the posterior external enamel inflection of p^4 has almost disappeared in the type and another specimen, but shows no signs of breaking up into three little fossettes, as it apparently has done in the type of *S. nebrascensis*. The specific validity of these distinctions in the tooth pattern is very questionable; the two sides of a single skull seldom agree at all closely, and this may well be an advanced mutation or subspecies of *S. nebrascensis*, the large bullæ being the clearest distinction.

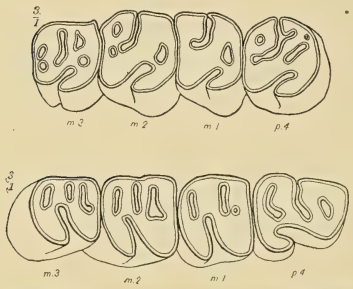


Fig. 6. *Steneofiber peninsulatus.* Upper and lower molars. x $\frac{2}{3}$. Type. No. 6998. John Day (? Diceratherium Beds), Oregon.

3. **S. gradatus.** The type skull, and the palate of a somewhat older individual are in the Cope Collection. It is a smaller animal than the two preceding species, with short, wide muzzle, postorbital constriction moderate, brain-case short and rounded, temporal crests not uniting to form a single

sagittal crest for some distance back of the postorbital constriction. Bullæ of moderate size; grinding series of teeth near together anteriorly, divergent posteriorly. The teeth decrease in size from p^4 to m^3 more than they do in *S. nebrascensis* or *S. peninsulatus;* there is but one fossette anterior to the external enamel inflection on the type, while our referred specimen of *S. nebrascensis* shows two, neither near extinction, although the teeth have attained the same stage of wear. The external enamel inflection has given off a small fossette on the left premolar of the type, but not on the right one; in both type and referred specimen the fossette of the posterior enamel inflection has disappeared.

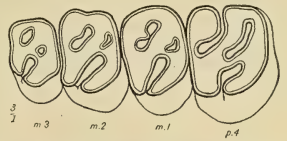


Fig. 7. *Steneofiber gradatus.* Upper molars x $\frac{2}{1}$. Type. No. 7007. John Day (? Diceratherium Beds), Oregon.

4. **S. pansus.** The upper and lower jaws are the only parts of the head known, and I have no certainly referable material to asisst in determination of the characters. Professor Cope's figures indicate an old individual, and apparently that the posterior enamel inflection of the upper teeth was more deeply impressed than in *S. gradatus*, which it resembled in the presence of but one fossette anterior to the median enamel inflection. The form and proportions of the molars, on which Professor Cope relied to distinguish it from other species, are merely a matter of age, as far as any separation from *S. peninsulatus* and *nebrascensis* is concerned. The bullæ are very large, as in *peninsulatus*, which it most nearly approaches as far as known, although presumably distinct, as it is recorded as found at a much higher horizon.

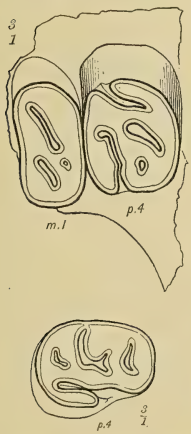


Fig. 8. *Steneofiber montanus.* Upper and lower molars x $\frac{2}{1}$. Type. Lower Beds of Smith Creek, Montana (Lower Miocene).

5. **S. montanus.** Allied to *S. nebrascensis*, but larger, with somewhat longer teeth, and enamel inflections deeper and more complex. The type is an old individual, whence the antero-

posterior direction of the internal upper and external lower enamel inflections, on which Professor Scott largely relies to distinguish the species. Two anterior fossettes are preserved on p^4, while the posterior fossette has already disappeared.

6. **S. hesperus.** Founded on the lower jaw of a young individual which is certainly close to *S. montanus* if not identical; the difference in age prevents any accurate comparison. The size is the same at similar points of wear; the upper incisors are more rounded externally, but the value of this character is doubtful. The depth and complexity of the enamel folds, as nearly as I can judge on the specimens, correspond fairly well.

Fig. 9. *Steneofiber hesperus.* Lower molars x ⅔. Type. White River, Montana.

7. **S. complexus.** Founded on the anterior half of the skull and jaws of an animal younger than any of the preceding types, still retaining the milk premolars. The skull has the long, slender muzzle of *S. nebrascensis;* the postorbital constriction is moderate, and the temporal crests do not unite into a sagittal crest, but are separate, as in *S. gradatus*. The difference in wear precludes comparison of the teeth with those of the remaining species; the dimensions of the masseteric scar and coronoid process given by Mr. Douglas as distinguishing characters likewise change with age so much as to be unsafe specific distinctions. The separate temporal crests may constitute a valid specific distinction.

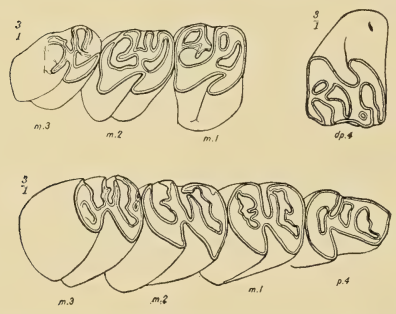


Fig. 10. *Steneofiber complexus.* Upper and lower molars. x ⅔. Type. White River (?), Montana.

Eucastor (*Leidy*) *Allen.*

This genus is represented by a single species found as yet only in the Nebraska Loup Fork. The teeth are considerably

more hypsodont than in the American *Steneofibers;* the molars have but one internal and one external enamel inflection (fossettes in the type specimen). The upper premolar has three external and the lower premolar three internal inflections, as in *Steneofiber* and *Castor*. The position of *Eucastor* is very doubtful; if, indeed, it is a true Castorid at all, it cannot be very nearly allied to either *Castor*, or *Steneofiber*. To this genus and species probably belong, besides the type, parts of two lower jaws in the Cope Collection.

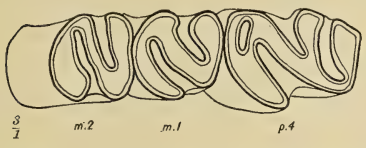


Fig. 11. *Eucastor tortus* Leidy. Lower molars x 3/1. No. 8332 (Cope Coll.) Loup Fork (Republican River Beds), Nebraska.

OTHER CASTORIDÆ FROM THE LOUP FORK.

The two isolated teeth which form the type of Leidy's *Hystrix venustus*, if they are really from the Loup Fork, are much more likely to be Castorid than Hystricid, the latter not being likely to occur as far down in the Tertiary of the Western States as the Miocene. Possibly with these species should be associated a broken tooth from the Colorado Loup Fork, of the same size and general proportions and pattern as *H. venustus*. Another isolated tooth from the same beds, No. 9364, represents a species probably undescribed, a little larger than *S. montanus*, more hypsodont and of more complicated pattern. A third specimen is part of a lower jaw with m_2–$_3$, the latter just emerging. This is much more brachydont than *Steneofiber*, although of somewhat the same general pattern, and somewhat smaller than the described species. The style of the teeth suggests *Spalax* rather than any other genus of Rodentia with which I am acquainted.

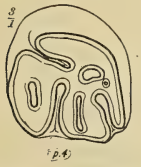


Fig. 12. *Steneofiber* sp. indesc. Upper premolar x 3/1. No. 9364. Loup Fork (Pawnee Creek Beds), Colorado.

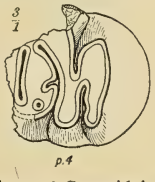


Fig. 13. ? Castorid, indet. x 3/1. Loup Fork (Pawnee Creek Beds), Colorado.

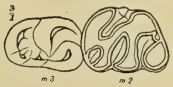


Fig. 14. ? Castorid, indet. Last two lower molars x 3/1. Loup Fork (Pawnee Creek Beds), Colorado.

LEPORIDÆ.

Palæolagus *Leidy.*

The genus was based on the division of the anterior lower premolar into two columns, instead of three as in *Lepus*. The dentition and characters of the front of the skull and of parts of the skeleton were fully figured and described at length by Professor Cope in his 'Tertiary Vertebrata,' and have been further discussed and revised in recent papers by Dr. Forsyth-Major on the Lagomorpha. We are now enabled to add certain skull characters, not hitherto known.

Palæolagus has a well-developed postfrontal process in all four species, scarcely less than in *Lepus ennisianus*, but much less than in modern Lepores. The angle between basicranial and basifacial axes varies considerably in the different species, but in none is it as great as in the modern species of *Lepus*. The brain is relatively smaller than in *Lepus*. The tooth pattern varies greatly during life; in the young it approximates that of *Lepus*, especially in such species as *L. ennisianus;* in the old animal it becomes much simpler. *P. agapetillus* is the most advanced in tooth, but least in skull, characters; *P. intermedius* most nearly approaches the John Day *Lepus*.

The pattern of the teeth changes greatly in *Palæolagus*, apparently from the superposition of a new pattern (that of *Lepus*) on an older and simpler one. The young individuals show an internal inflection on the upper molars, whose depth and persistence varies in the different species; there is also an external inflection, never deep, but rather persistent, and a median crescent which originates as an anterior marginal inflection on p^2, an anteroexternal one on p^3 (apparently median-external on p^4 and m^1), a postero-

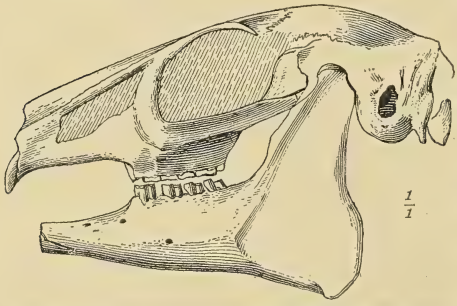


Fig. 15. *Lepus ennisianus.* Cope. Skull and lower jaw natural size. Type specimen No. 7190. John Day, Oregon. Muzzle supplied from another individual.

external one on m^2, and a posterior one on m^3. The median crescent is somewhat less persistent than the internal inflection. Enamel is lacking on the external side of the teeth except in very young animals.

The internal inflection is that which has become deeper and more persistent in *Lepus;* the crescent has disappeared in modern species of *Lepus*, and in the John Day *L. ennisianus* apparently does not persist as long as in *Palæolagus*. The enamel fails on the external side of the upper teeth of *Lepus* except for a little while after they are protruded.

Dr. Forsyth-Major has suggested that the second upper incisor of the Lagomorpha has originated from the posterior cusp of such a tooth as that of *Plesiadapis;* the bifanged tooth splitting in two and the large anterior cusp giving rise to the large incisor of the modern lagomorph. *Palæolagus*, he thinks, might help to verify this theory. But the incisors of *Palæolagus* are quite of modern type. It is to the lower Eocene Rodentia, including the Mixodectidæ, or to the as yet little-known fauna of the Cretaceous, that we must look for light on the method of evolution of their teeth. But Eocene Lagomorpha have not yet been discovered.

Palæolagus approaches most nearly to Forsyth-Major's *Caprolagus* group among modern Leporidæ. These species are less specialized for speed, and in consequence the head is carried lower and more forward, and the basicranial and basifacial axes are at a smaller angle.

Angle between basifacial and basicranial axes in different species of Palæolagus and Lepus.

P. agapetillus	7°
P. intermedius	20°
P. haydeni	22°
L. ennisianus	33°
L. campestris	47°

Palæolagus ? agapetillus *Cope.*

Professor Cope held this species as distinct in 1874, but in 1884 united it with *P. haydeni*. A skull found by our party

in 1898 in the upper levels of the White River beds appears distinct from *P. haydeni*. It is smaller, more narrow and elongated, the muzzle more slender. The anterior half of another skull and several jaws, chiefly or all from the same upper horizon, may be referred here, although they approach *P. haydeni* somewhat more nearly than does the complete skull. The distinctive characters are: slender and narrow muzzle, small teeth, internal median fold of enamel on upper molars more deeply incised and more persistent than in *P. haydeni*. The species appears to be good, on the evidence of some half-dozen specimens referred to it and compared with the very numerous *P. haydeni* specimens in our collections. Whether the type of *P. agapetillus* is properly referred to it, I am unable to decide; but leave it provisionally.

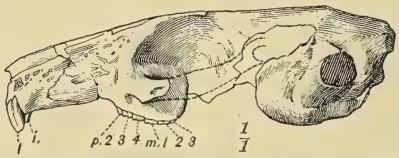


Fig. 16. *Palæolagus ? agapetillus*. Skull, natural size. No. 8704. White River (Martin Cañon Beds), Colorado.

Palæolagus haydeni *Cope.*

Tricium annæ Cope; *Tricium avunculus* Cope; *Tricium leporinum* Cope.

The additional specimens collected by American Museum parties include no complete skull of this species. The best one, No. 9327, shows a skull shorter and wider than *P. agapetillus* or *intermedius*, brain-case rounder than in either, basifacial axis bent down about as in *P. intermedius*, arch heavier than in *Lepus ennisianus*, the jugal a band of uniform width, thickened at the upper and lower margins. Teeth larger than in *P. agapetillus*, less transversely broadened, medial internal furrow less deeply incised or persistent. A scapula, vertebra, and metapodial, associated with this specimen, agree in size with Cope's skeleton material of *P. haydeni*.

Palæolagus intermedius *Matthew.*

Type, a nearly complete skull from the upper levels of the White River, at Castle Rock, Cedar Creek, Col. Associated

type, upper and lower jaws and fragments of skeleton from same level and region.

This skull is much more depressed on the basicranial axis than *P. agapetillus;* it has a long and heavy muzzle, unlike the slender, sharp muzzles of the two preceding species; the teeth are larger than those of *P. haydeni*, but resemble them in pattern; the length of the diastema is equal to that in *P. turgidus*, but the teeth are much smaller, and of more *Lepus*-like pattern; the skeleton appears to be as large as that of *P. turgidus*, and of similar proportions. The postfrontal process is nearly as large as in *Lepus ennisianus;* the muzzle is of the same length as in that species, but heavier; the basifacial axis is somewhat less depressed, and the brain-case is distinctly smaller.

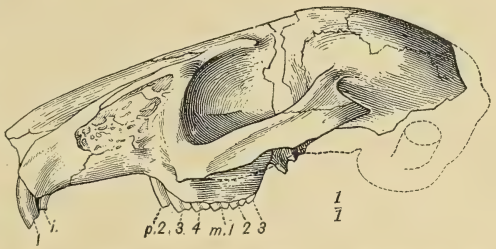


Fig. 17. *Palæolagus intermedius.* Skull, natural size. Type. No. 8722. White River (Martin Cañon Beds), Colorado

Palæolagus turgidus *Cope.*

P. triplex Cope; ? *Tricium paniense* Cope.

Young jaws of this species show a third lobe on the p_4–m_2 and a third lobe on p_3, both of which disappear in the old animal. The jaw on which *P. triplex* was founded appears to be a juvenile stage of *P. turgidus*, in which these characters are very marked. We have no other jaws of the same age; but if the twelve or fourteen examples of lower jaws be arranged according to age (determined by wear on end of p_3) they form a perfect series from *P. triplex* to the type of *P. turgidus.* Cope, in comparing the series, came to the conclusion that the difference between *P. turgidus* and *P. triplex* could not be entirely explained as a matter of age; but the present writer is unable to see sufficient difference to warrant the retention of the species.

Part of a skull, No. 1429*a*, is referred here; it belongs to a very old individual, and the tip of the muzzle and brain-case are missing. It appears to be a short-skulled species, considerably broader but not much longer than *P. intermedius;* the angle of the basifacial axis cannot be determined, and the teeth are very much worn, so that the internal inflection of the enamel has disappeared on the molars, although it persists on pm_4.

Very little additional material of this species has been found by our party, and none that throws any new light on the younger stages of tooth-change, so that Professor Cope's provisional reference of *Tricium paniense* (juvenile *P. turgidus*) cannot be confirmed.

Palæolagus temnodon *Douglas.*

Allied to *P. haydeni* but probably distinct, as it comes from a lower horizon and a widely separate locality.

Article XXIII. — THE SKULL OF HYPISODUS, THE SMALLEST OF THE ARTIODACTYLA, WITH A REVISION OF THE HYPERTRAGULIDÆ.

By W. D. Matthew.

A very well-preserved skull of this tiny Artiodactyl was found by the writer at Pawnee Buttes, northeastern Colorado. In connection with the fragments of the skeleton already described from the same region, it gives a fairly complete idea of the characters.

The animal was not larger than a 'cottontail' rabbit. The orbits are remarkably large, as are likewise the tympanic bullæ. The tip of the muzzle is unfortunately missing, but enough is preserved to show that it was slender and short. The whole skull is distinctly more brachycephalic than in any other White River selenodont—more so, indeed, than in any of the modern Cervidæ or Antilopidæ with which I have compared it. The molar dentition consists of five teeth in each jaw, $p\frac{3}{3} - m\frac{3}{3}$; $p\frac{2}{2}$ is present in young individuals and repre-

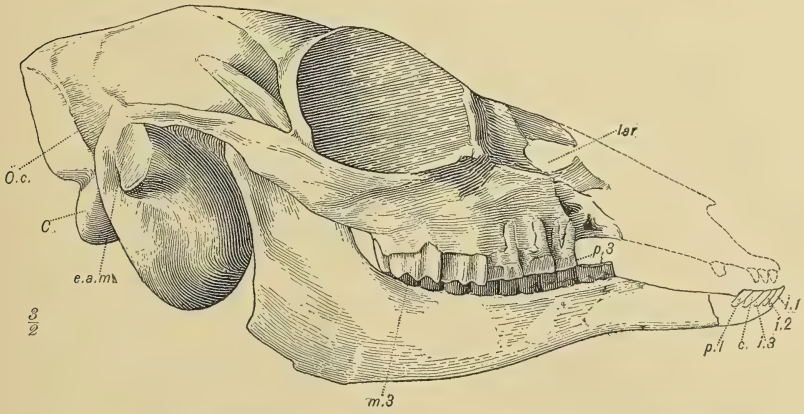


Fig. 1. *Hypisodus minimus* Cope. Skull, x $\frac{3}{2}$. No. 9354. White River (Cedar Creek Beds), Pawnee Buttes, Colorado.

sented by an alveolus in the older animals. A considerable diastema is in front of this alveolus in the upper jaw, and

anteriorly to this the muzzle is broken off on both sides (or is not calcified). A longer diastema precedes the alveolus of p_2 in the lower jaw, and in front of that, on evidence of other specimens, it is known that there are five small subequal teeth, probably incisiform.

The antorbital foramen is double, opening above the diastema in front of the molar series. There appears to be a small prelachrymal vacuity. The postorbital bar is complete. The orbit is surrounded by a thin prominent ring, of which the inferior and anterior parts (jugal and lachrymal) are more prominent, and the superior part (frontal) less prominent than in *Hypertragulus* or *Leptomeryx*. The eye, therefore, faced much more upward than in these genera; it was more prominent and much larger in proportion. The basifacial axis is much more bent down on the basicranial axis than in other Hypertragulidæ. The bullæ are very large, connate anteriorly, with a long, prominent, enclosed meatus opening behind the origin of the zygoma. The occiput projects much more backward than in *Hypertragulus* or *Leptomeryx*. The paroccipital processes are slender, and are coössified with the bullæ except just at the tip.

The lower jaw is slender, its condyle set high up, and the long coronoid process is slightly curved. It does not possess the angular hook seen in certain of the Camelidæ.

The limbs and feet I have described in a previous article. The ulna and radius are coössified, and the distal end of the fibula is coössified with the tibia. The cuboid and navicular were coössified, the median metatarsals distinct though appressed, the laterals thread-like but still complete.

Hypisodus was much less *Tragulus*-like than *Hypertragulus* or *Leptomeryx*, and superficially resembled rather the dwarf antelope *Madoqua*. Its real relationships are more nearly with *Hypertragulus* than anything else, but it is a remarkably modernized animal for the formation in which it is found. The resemblance to *Madoqua* is a striking instance of parallel adaptation.

Family HYPERTRAGULIDÆ Cope.

(LEPTOMERYCIDÆ *Scott.*)

Leptomeryx *Leidy.*

Dentition, $I\frac{0}{3}$ $C\frac{0-1}{1}$ $P\frac{3}{4}$ $M\frac{3}{3}$. Lower canine incisiform, first premolar small, caniniform, with a long diastema in front of it and a somewhat shorter one behind. Upper canine small or absent. Second, third, and fourth premolars in series with molars, p^4 with two crescents, p^{2-3} with anterior, posterior, and internal accessory cusps. Mesostyle prominent on upper molars. Second, third, and fourth lower premolars in series with molars, trenchant, with anterior basal cusp, basin heel, and accessory ridges from the protoconid. Last molar with heel composed of a large posteroexternal crescent and a small anterointernal flattened cusp (as in *Palæomeryx*).

Skull of moderate length, muzzle slender, elongated, orbits not very prominent. Prelachrymal vacuity diamond-shaped, situated rather above than in front of the lachrymal. Bullæ small, not filled with cancellous tissue.

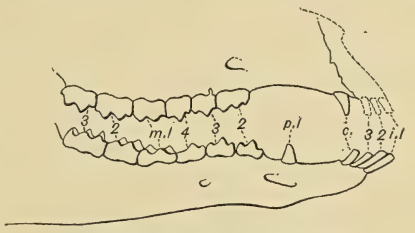


Fig. 2. Dentition of *Leptomeryx*.

Ulna and radius separate; tibia and fibula separate; navicular and cuboid united. Manus of four usable digits, the lateral pair smaller, no cannon-bone. Pes with cannon-bone and no lateral digits (? the small proximal splints of metatarsals II and V fused to the cannon-bone). Hoofs small, pointed.

1. **L. evansi** Leidy. White River (Oreodon Beds). S. Dak.

Leidy, Ext. Mam. Dak. and Neb., p. 165, pl. xiv, figs. 1–8.— Scott, Jour. Morph., V, Dec. 1891. Scott, Trans. Wagn. Inst. Sci., 1899. 15.

2. **L. mammifer** Cope. White River (? Titanotherium Beds), Swift Current Creek, Canada.

Cope, Rep. Geol. and Nat. Hist. Surv. Canada, I, 1885 (1886), 84*c*.

One and a half times the linear dimensions of *L. evansi*. Prof. Cope distinguished it by the presence of a separate cusp between the entoconid and the heel of m^3; this appears, however, to be only the anterointernal cusp common to all species of *Leptomeryx*.

3. **"L." esulcatus** Cope. White River (? Titanotherium Beds), Swift Current Creek, Canada.

Cope, Mem. Geol. Sur. Can. III, 1891, 22, pl. xiv fig. 5.

Based on a single upper molar, which, judging from Cope's figure, is not *Leptomeryx*, suggesting rather an ally of *Palæomeryx*, so far as such slight evidence is worth consideration.

4. **"L." semicinctus** Cope. White River (? Titanotherium Beds), Swift Current Creek, Canada.

Cope, *l. c.*, p. 23, pl. xiv, fig. 8.

This species is also known by a single upper molar. It has twice the linear dimensions of *L. evansi;* tooth broader transversely, with heavy cingular ridge (protostyle) internal to protocone and strong cusp (hypostyle) anterointernal to hypocone. This is clearly not *Leptomeryx*, and is distinct from any described White River genus (except possibly *Calops*, with which I am unable to compare it; Prof. Marsh states, however, that the molars of *Calops* are like those of *Protoceras*, in which case it is not "*L.*" *semicinctus*). Two upper molars in the Am. Mus. Collection from the Protoceras Beds of South Dakota probably represent this species.

5. **Leptomeryx** sp. indesc.

A smaller species occurs in the Leptauchenia clays in Colorado and in the Protoceras Beds of South Dakota distinguished by simpler premolars, narrower, more hypsodont molars. The deuteroconid of p_4 is not distinct as in *L. evansi*, but represented only by a ridge descending anterointernally from the point of the protoconid; p_3 is smaller and more trenchant; the internal faces of the molar cusps are more convex. This may prove varietal when *L. evansi* is examined from more localities and regions.

6. **Leptomeryx** sp. indesc.

A larger, somewhat more brachydont species or variety, characteristic of the Protoceras sandstones. Premolars pro-

portionately larger, longer, and more complicated; antero-internal cusp of p_4 less prominent, posterointernal (hypostylid) more so; hypoconid ridge bifid posteriorly, into a posterior branch which passes backward to the posterior margin, and a posterointernal branch projecting into the basin of the heel. P_1 more anterior in position than in *L. evansi*, probably near anterior end of diastema, while in *L. evansi* it is nearer to p_2 than to c_1.

Hypertragulus *Cope.*

Dentition, $I\frac{?}{?}$ $C\frac{1}{1}$ $P\frac{4}{4}$ $M\frac{3}{3}$. Lower canine incisiform, first premolar large, fully caniniform, with a short diastema in front and a long one behind. Upper canine enlarged, first upper premolar two-rooted, with diastema before and behind. Second lower premolar spaced, simple, without accessory cusps; third with heel; fourth with anterior cusp and heel; but all though equally trenchant simpler than the corresponding teeth in *Leptomeryx*. Second upper premolar simple, two-rooted; third with internal cusp; fourth with two crescents. No mesostyle on upper molars. Heel of last lower molar composed of two equal opposite crescents. Molars somewhat more hypsodont than those of *Leptomeryx*.

Fig. 3. Dentition of *Hypertragulus*.

Skull much like that of *Leptomeryx*, but somewhat shorter, muzzle slenderer, supraorbital ridges much more prominent. Prelachrymal vacuity as in *Leptomeryx*, bullæ somewhat larger.[1]

Ulna and radius coössified; tibia coössified with distal end of fibula; navicular and cuboid united. Manus of four separate usable digits; pes with two separate digits and splints representing the lateral metatarsals.

[1] In his recent discussion of this genus Prof. Scott interprets the dentition as $I\frac{?}{3}$ $C\frac{1}{1}$ $P\frac{3}{3}$ $M\frac{3}{3}$, the first premolar absent and lower canine caniniform. It would appear rather that, as in most other selenodonts, the canine is incisiform. The number of incisors is not certainly known; but it seems certain that both in the John Day skulls on which Prof. Scott's description and figures were based, and in the White River skulls in the Amer. Mus. collection, the inferior tooth, which Prof. Scott considers as a canine, closes behind, not in front of, the upper canine; his drawing does not agree with the specimen in this respect. The one skull from the White River in which this part is preserved shows the lower caniniform tooth shutting unmistakably behind the upper canine; it is, therefore, a premolar, and the canine is incisiform as in *Leptomeryx*.

1. **Hypertragulus calcaratus** Cope. White River, Oreodon Beds.

H. tricostatus Cope.[1] Not *H. calcaratus* "Cope" Scott, Trans. Wagn. Inst. Sci., 1899.

2. **Hypertragulus** sp. indesc. John Day.

Hypertragulus calcaratus Scott, Trans. Wagn. Inst., 1899, pl. i, figs. 3–4.

The John Day specimens referred by Profs. Cope and Scott to *H. calcaratus* are a larger, more brachydont species, with heavier muzzle, etc.

3. **"Hypertragulus" transversus** Cope. White River, Titanotherium Beds (?), Swift Current Creek.

Cope, Mem. Geol. Sur. Can. III, 1891, 22.

Twice the linear size of *H. calcaratus*, para- and metacones uniformly convex externally, small para- and metastyles and prominent hypostyle anterointernal to hypocone. It is not at all probable that this species is *Hypertragulus* or related thereto.

Hypisodus *Cope.*

Dentition, $I\frac{?}{3}$ $C\frac{?}{1}$ $p\frac{?(3-4)}{3-4}$ $M\frac{3}{3}$. Lower canine incisiform, first premolar small, probably incisiform. Second upper and lower premolars decadent at anterior end of grinding series. Teeth hypsodont, skull very brachycephalic, but muzzle rather long and slender. Prelachrymal vacuity irregular, orbits very prominent, bullæ very large. Lateral digits of pes extremely slender although still entire; no cannon-bone; ulna and radius united.

Fig. 4. Dentition of *Hypisodus.*

1. **Hypisodus minimus** Cope. White River (Oreodon clays).

[1] ". . . I know but the one species, the *H. calcaratus* Cope."—Cope, Proc. Amer. Phil. Soc., 1884, Vol. XXII, p. 24. This statement invalidates *H. tricostatus*, and quite correctly so.

Article XXIV.—LIST OF THE PLEISTOCENE FAUNA FROM HAY SPRINGS, NEBRASKA.

By W. D. Matthew.

In 1893 and 1897 field-parties from the American Museum were sent out by Professor Osborn to collect in the Pleistocene at this locality, a bone-bed near the Niobrara River, not far from Hay Springs. A large collection of horse and camel remains was obtained, and a few specimens of other animals. The horses have been carefully studied by Mr. Gidley, the camels by Dr. Wortman; the remainder of the fauna has been revised and partially studied by the writer, but no results have hitherto been published. A list of the fauna may be of some interest to compare with that found in the Sheridan or Equus Beds at other localities. The appended lists, when based on materials in the Cope Collection, are from determinations by Professor Cope, revised in a few cases by the writer.

Hay Springs, American Museum Collection, 1893 and 1897.

Canis ? latrans. Lower jaw.

? Dinocyon or large Ursid. Metacarpal. This bone appears to exceed in size the corresponding parts in any living species of bear. The character of the diaclasts excludes it from the Felidæ or typical Canidæ, but the Amphicyonine Dogs are somewhat similar, and if not a bear it might represent a very large species of *Dinocyon* (*Borophagus*), a genus known to occur in the late Pliocene (Blanco).

? Felidæ indet. Several species are represented by foot-bones and fragments of limb-bones.

Fiber zibethicus. A skull and several jaws, all of which come within the limits of variation of the modern muskrat.

Arvicola, cf. **amphibius.** Upper and lower jaws.

Cynomys, cf. **ludovicianus.** Palate.

Thomomys sp. indet. Upper and lower jaws.

Castoroides sp. indet. Teeth, limb-bones, and astragali.

Mylodon sp. indesc. A complete skull, jaw, and large part

of the skeleton of a sloth allied to but distinct from *Mylodon harlani.* Description is reserved for the present.

Equus complicatus Leidy. This, the first-described and most characteristic of American fossil horses, is by far the most abundant fossil at the Hay Springs locality. Numerous bones of all parts of the skeleton were obtained.

Equus fraternus. Smaller and not nearly as abundant as *E. complicatus.*

Equus ? scotti Gidley. Upper and lower jaws.

Elephas primigenius columbi. Tusk, several foot-bones, and grinders.

Platygonus vetus Leidy. Palate.

Platygonus compressus Leconte. Upper and lower jaws.

Undescribed Porcine, cf. ? *Leptochœrus.* Upper premolar (obtained in digging a well near Hay Springs).

Camelops kansanus Leidy. Parts of jaws, teeth, vertebræ, limb- and foot-bones. More than one species is quite probably represented, but the material does not warrant attempt at separation.

Camelops vitakerianus Leidy. Teeth, jaw fragments, etc.

Camelus americanus Wortman. Lower jaw.

Antilocapra, cf. **americana.** Parts of jaws, limb- and foot-bones.

Capromeryx furcifer, n. g. et sp.

A small jaw containing p_2–m_3 indicates an animal allied to *Antilocapra* and somewhat more nearly to *Merycodus*, but generically distinct from either. The premolars are most nearly like those of *Merycodus;* p_4 is long, trenchant, simple, lacking the deuteroconid; p_3 and especially p_2 are more complicated. In *Antilocapra* p_4 is shorter, with prominent deuteroconid, and the anterior premolars are short and simple, thus approaching the premolar characters of goats and sheep. The molars in *Capromeryx* are fully as hypsodont as in *Antilocapra*, much more so than in *Merycodus*, which more nearly approach the brachydont teeth of the deer.

The species was of about two-thirds the (lineal) dimensions of the American antelope.

This unexpected addition to the short list of Ruminants of the American Pleistocene is rather interesting despite its fragmentary character. It is, much more certainly than *Antilocapra*, descended from the little group of antelopine deer of the American Miocene, of which *Blastomeryx*, *Cosoryx*, and *Merycodus* are the known forms. This group is characterized by the combination of antlers approaching those of the deer and teeth approaching those of the antelopes. The antlers are forked or several times branched, provided usually (if not always) with a burr,—hence, in Professor Cope's opinion, deciduous; smooth surfaced,—hence probably covered permanently with 'velvet.' The teeth are more hypsodont than in any of the deer, less so than in *Antilocapra*, and the premolars have preserved somewhat of that primitive, long, trenchant character seen among modern genera only in *Tragulus*, but generally present among the older Tertiary selenodonts. *Blastomeryx* (*B. gemmifer*) is the oldest, smallest, and most brachydont genus; *Merycodus* is more hypsodont. *Cosoryx* has a simple forked antler, just above the eyes, like the horn of *Antilocapra*, with a burr at base, and quite hypsodont teeth.

Blastomeryx has antlers like those of the Virginia deer, but I have not seen more than four tines; the face is very short and the antlers more nearly over the eyes than in modern deer, less so than in *Antilocapra*. The position of *Merycodus* is uncertain; present evidence indicates that it may be distinct from *Cosoryx*. The large, completely brachydont species referred by Cope and Scott provisionally to *Blastomeryx* and by Douglas to *Palæomeryx* are distinct from any of these antelopine deer (and from any European genus as well), forming a transition between them and the contemporary and later true deer of Europe and America. The new genus, *Capromeryx*, may, when better known, prove to be a transition between the antelopine deer and *Antilocapra*.

The above list is obviously a plains fauna. Horses and camels are the most abundant. There are antelopes, but no deer; Canidæ are found, but few if any Felidæ. *Platygonus*

is much more swift-footed and more advanced in dentition than is the modern peccary, and may be supposed to have lived more in the open. Prairie-dogs, gophers, and field-mice are now to be found on the plains in the same region, and muskrats along the streams. Of the habits of *Mylodon* we know little; perhaps it, like the mammoth, frequented the watercourses and valleys of open country, rather than the denser forest regions which were the home of the contemporary mastodons. The *Castoroides* remains are too fragmentary to tell whether it was the same as the eastern species.

SILVER LAKE (LAKE CO.), OREGON.[1]

Canis ? *latrans*, jaws, limb- and foot-bones.
Canis, cf. *occidentalis*, limb- and foot-bones.
Vulpes, cf. *pennsylvanicus*, femur and tibia.
Lutra canadensis, front of skull, jaws, limb-bones.
Fiber zibethicus, jaws, limb-bones.
Arvicola sp. div., jaws, limb-bones.
Thomomys sp., skeleton nearly complete.
Geomys sp., jaws, limb-bones.
Castor sp., one molar.
Castoroides sp., teeth.
Lepus sp. (cf. *campestris*), parts of jaws, limb-bones, etc.
Mylodon sodalis Cope (? = *M. harlani*), phalanges.
Equus pacificus, numerous bones from all parts of skeleton.
Elephas primigenius ? *columbi*, teeth, foot-bones, vertebræ, etc.
Platygonus, cf. *vetus*, teeth.
Platygonus sp. minor, teeth.
Eschatius conidens, parts of jaws.
Camelops kansanus, parts of jaws, limb- and foot-bones.
Camelops vitakerianus, upper jaw, ? foot-bones.
? *Camelops* sp. max., teeth, foot-bones, etc.
Antilocapra, fragments of feet.

With the above mammalia were found numerous bird remains, which have been studied by Dr. Shufeldt.

[1] Revised from Prof. Cope's list.

This is equally a plains fauna, with two aquatic mammals, *Castor* and *Lutra*, not found at Hay Springs. Otherwise the list is very similar to that of Hay Springs, and, like it, is characterized by the absence of the forest types found in the Pleistocene cave deposits, river-gravels, and peat-bogs of the East.

Oregon Desert.

A collection made by Geo. C. Duncan at some point or points of which I can find no exact record. The collection was considered as of Pliocene age by Professor Cope, because it contained *Equus*, *Hipparion*, and *Teleoceras*, along with less characteristic remains referred to *Holomeniscus* (= *Camelops*) and *Elephas*. The *Equus* and *Elephas* bones, however, are from a different matrix from the other bones, and the *Holomeniscus* is more probably *Pliauchenia* or *Procamelus*. They are, therefore, probably from two distinct formations, the older one of the age of the later Loup Fork, the newer one of the age of, if not identical with, the Silver Lake Equus Beds.

Washtuckna Lake, Washington.

Taxidea sulcata (= *americana*), parts of skulls, jaws, limb- and foot-bones.
Felis, cf. *imperialis*, parts of limb-bones.
Felis, cf. *concolor*, parts of limb-bones.
Felis, cf. *canadensis*, parts of limb-bones.
Mylodon sp., astragali and foot-bones.
Equus sp., bones of feet and some teeth.
? *Camelops*, cf. *kansanus*, foot-bones.
? *Camelops*, cf. *vitakerianus*, foot-bones.
? *Camelops*, sp. max, foot-bones.
Alces brevitrabalis, parts of antlers, foot-bones, etc.
Alces semipalmatus, parts of antlers, foot-bones, etc.
Cariacus ensifer, parts of antlers, foot-bones, etc.
Oreamnus, parts of horn.

This fauna shows a large proportion of forest and mountain types, and no aquatic mammals. It is a very inadequate list,

and I have seen no description of the locality where the specimens were found, but it is probable that the physical conditions were quite different from those prevalent in the Silver Lake and Hay Springs localities.

Article XXV.—BORING ALGÆ AS AGENTS IN THE DISINTEGRATION OF CORALS.

By J. E. Duerden, Ph.D., A. R. C. Sc. (Lond.).

Plate XXXII.

J. Queckett in his 'Lectures on Histology' (London, 1854) first drew attention to the fact that corals are frequently penetrated in all directions by tubules, which are now known to result from the growth of filamentous plants within the calcareous skeleton. A few years later Prof. A. Kölliker (Proc. Roy. Soc., Vol. X, p. 95, 1859) described similar tubes in the horny fibres of sponges, the tests of Foraminifera, and many molluscan and brachiopod shells, as well as in numerous corals. Kölliker considered them all as parasitic unicellular fungi. Prof. Moseley in 1875 (Proc. Roy. Soc., Vol. XXIV, p. 64) found the coralla of both *Millepora* and *Pocillopora* to be permeated by fine ramified canals, formed by parasitic vegetable organisms. These were green in color, in abundant fructification, and were regarded by Moseley as fungi.

The late Prof. P. M. Duncan in 1877 (Proc. Roy. Soc., Vol. XXV, p. 288) published the results of a thorough investigation into the subject of Thallophytes boring into recent Madreporaria. Six different species of corals were examined, of which apparently *Balanophyllia verrucaria* Pallas was the only available fresh material. Duncan found no chlorophyll in the filaments liberated on decalcification, and came to the conclusion that the principal parasite was a fungus allied to the Saprolegniæ; this he named *Achyla penetrans*. The fungoid character of the boring organism has been accepted by recent writers on coral morphology, such as Bourne and Ogilvie. In an Appendix to his communication Prof. Duncan refers to thread-like, dark green organisms of a vegetable nature which ramify on the surface of certain deep-sea corals (363 fathoms) and penetrate within it.

MM. Bornet and Flahault in 1889 (Bull. Soc. Bot. de France, Tom. XXXVI) published an important contribution upon the plants living within the calcareous shell of molluscs.

They summarize the results of previous observers and recognize in all ten different genera of shell-boring plants: four, of which *Gomontia* is the principal, belong to the green algæ (Chlorophyceæ), four to the blue-green algæ (Cyanophyceæ), and two are probably fungi. Representatives from the red algæ (Rhodophyceæ) have since been added by later workers. The life history of most of the forms is yet imperfectly known. Bornet and Flahault point out the very important rôle which boring plants play in the corrosion and ultimate disintegration of molluscan shells, especially in quiet bays where the shells are not mechanically broken up by the incessant action of the waves.

The papers above mentioned contain references to other accounts of boring algæ and fungi, all of which seem to indicate that Thallophytes infest and assist in the disintegration of nearly every form of calcareous matter. Their filaments have been met with in Foraminifera, corals (recent and fossil), the calcareous tubes of annelids and cirripedes, molluscan shells (empty and living), fish scales, and calcareous pebbles. Apparently the endodermal skeleton of echinoderms is free from their attacks.

On macerating freshly collected Jamaica corals I have often found specimens which exhibited irregular green patches over a greater or less area of the newly exposed skeletal surface, the coloration varying much in intensity. Occasionally colonies were obtained in which the color was a delicate red. The old, partly corroded, under-surface of freshly gathered corals is also frequently green. The fresh surface of the corallum gives no indication as to the cause of the green or red color, so that evidently it is within the skeleton itself. Fracturing the coral serves to establish that the coloration penetrates only a short distance below the surface, and in the interstices minute green filaments can be seen ramifying over the surface of the dead corallum and frequently extending across the dissepimental chambers. On exposure to the tropical sun for several days or weeks the corals usually become bleached, but after a period of two or three years certain specimens stored in cases still retain a faint green or pink tinge.

Again, in the course of a morphological study of West Indian coral polyps, I have decalcified numerous preserved colonies or fragments of such belonging to about thirty different species, all obtained from shallow water. In almost every instance the space from which the calcareous skeleton was removed was found to be occupied by a colorless, green, or red mass of fluffy texture, which on examination under the microscope proves to be made up of filamentous algæ, sometimes mixed with fine particles representing the organic matrix of the skeleton. The filaments obtained from near the surface of the corallum are colored, due either to the presence of chlorophyll or to a red cell fluid; while those more internal are colorless and contain but little protoplasm, suggesting a non-active condition. There can be no doubt that the coloration seen on freshly macerated coralla is due to the occurrence of these perforating green and red algæ in great abundance. Where present in less numbers the filaments do not sensibly affect the usual white appearance of a coral skeleton.

The filaments to which special attention has been given were obtained in every case from the living region of the colony, that is, from the more superficial part of the corallum which is covered by the polypal tissues. Of the green algæ only two species occur: one with transverse walls, probably belonging to the genus *Gomontia* (Fig. 3), and another with continuous tubes, belonging to the group of the Siphoneæ, probably an *Ostreobium*[1] (Fig. 1). Both are extremely variable as regards the size and form of the filaments, and are often closely intermingled in the same specimen of coral. Sometimes a filament will extend for a great distance without branching. At other times the unicellular form will branch frequently in a somewhat dichotomous manner and assume a root-like appearance; or, again, its filaments may pass uninterruptedly into spheroidal, club-shaped, or irregular enlargements filled with spore-like bodies (Fig. 2, *a–c*). The red alga is constituted of simple, closely intermingled filaments, and occurs much less fre-

[1] The botanical issues of the subject will be fully dealt with by Dr. G. T. Moore, Algologist of the United States Department of Agriculture, who is at present engaged upon a study of the boring algæ infesting West Indian molluscan shells.

quently than the green (Fig. 4). The red and green forms may occur together in the same coral. No fungus has been met with.

The non-septate green alga bears the closest resemblance, in the varying form of the filaments and also in its spheroidal club-shaped, or irregular sporangia, to the figures of *Achyla penetrans*, as given by Duncan and by Bourne (Trans. Roy. Dubl. Soc., Ser. II, Vol. V, 1893, pl. xxv), and no doubt they will prove to be the same. Duncan has shown that the fossil corals of Silurian age were also affected by closely allied, if not specifically identical, forms.

The universal presence of boring algæ in West Indian corals suggested an examination of corals from other regions. By permission of Prof. Alexander Agassiz, and through the courtesy of the officials of the Smithsonian Institution, I have been enabled to examine the collections of recent corals made by Prof. Agassiz during his explorations of the coral-reef areas of the Pacific in 1899–'00, and now deposited for report in Washington. The surface of many of the specimens, even where covered by the polypal tissues when alive, is yet strongly green in color; and the decalcification of fragments from some dozen species selected at random reveals in every case the presence of filamentous algæ. The filaments seem to differ in no respect from those remaining after the decalcification of West Indian corals, the non-septate form occurring in greatest quantity. The skeleton of the alcyonarian coral *Tubipora* was likewise infested with non-septate filaments, along with a filamentous blue-green alga.

The actual chemical and physical processes involved in the penetrative activity of the algal filaments is not yet definitely understood. The corroding action is probably similar to that observed when the roots of living plants come into contact with a slab of marble. Duncan (*l. c.*, p. 254) considered that the growth of the parasitic organisms within the hard calcareous structures was due to "the combined results of the formation of a soluble bicarbonate of lime by the action of the carbonic acid gas evolved from the growing end of the tubular filament, of the pressure incident to growth, and of the move-

ments of the cytioplasm and cell-wall." He regarded the cell-wall as being in close contact with the sclerenchyma of its canal, so that solution took place only at the growing apex, and the soluble product could pass outward only through the filaments themselves. Kölliker had expressed practically the same conclusion. Recently Karl Lind, in a paper entitled 'Ueber das Eindringen von Pilzen in Kalkgestein und Knochen' (Inaugural-Dissertation, Leipzig, 1898), has discussed very fully the different views as to the perforating action of fungal hyphæ. Experiments showed that the entrance of the hyphæ into plates of limestone, bones, etc., was dependent upon the presence of nutritive matter within the hard substance. Lind also concludes that carbonic acid produced by the organism is the chief agent in the solution of the calcareous matter, and that the soluble bicarbonate passes to the exterior not through the filament itself, but in a narrow interval existing between the hyphal wall and the calcareous boundary.

Apparently the corrosive action of perforating algæ has never received any attention in the numerous discussions which have taken place upon the possible factors in the destruction and disappearance of corals. Bourne (Trans. Roy. Dubl. Soc., Ser. II, Vol. V, 1893, p. 225) attributed to it considerable importance in the separation of the discoid *Fungia* form (Anthocyathus) from the pedicle to which it is primarily attached (Anthocaulus). The fragile nature of the dead part of the stems of *Mussa corymbosa* Bourne also considers to be due to their being bored by *Achyla* and by the boring sponge *Clione*. From my own observations in the neighborhood of coral reefs, extending over several years, I am disposed to accord the process of algal corrosion an important, if not the most important, part in the disintegration of coral masses. The results presented above give good reason for assuming that in general all corals are infested with boring algæ, even to their most superficial regions of growth. Among the thirty different species of West Indian corals examined the only places where filaments have not been found are at the growing apices of branching corals like *Madrepora* and *Oculina*. Here the calcareous deposition apparently takes place a little in ad-

vance of the upward growth of the algal filaments, for the latter are always to be found in the older parts of the corallum.

Decalcification of the dead stems and under parts of colonies usually discloses a still greater abundance of filaments of the true boring types, while from the actual surface is obtained an immense variety of other vegetable growths. On the shores of the quieter bays and lagoons the fragments of dead corals picked up are frequently green in color, and exhibit all stages in the process of corrosion.

The decalcification of so-called 'rotten' coral is also found to leave behind large quantities of a fluffy material, nearly the whole of which is algal matter in a living, active condition. But in addition to the two species of algæ usually occurring in the living regions of a colony many other forms are found, crowded in such a manner that it is difficult to say which actually penetrate the skeleton and which are only superficial. Two different representatives of the blue-green algæ are often present, and frequently a *Leptothrix*-like bacterium. Boring sponges sometimes occur, but in my experience are not very common in corals. 'Rottenness' in corals would thus appear to be largely due to the corrosive action of algæ, supplemented by the boring animal organisms referred to below.

In addition to the possible solution of calcareous corals by the carbonic acid in sea-water the principal factors which have hitherto been considered as leading to their destruction are the various animal forms infesting the skeleton. Most writers have pointed out the influence in this direction of the numerous boring molluscs, sponges, echiurids, and echinoids, and the cirripedes and annelids frequently included within the corallum. All these undoubtedly weaken the skeleton greatly and must facilitate its fragmentation when rolled about by the waves. Mere fragmentation, however, will result only in the formation of coral sand or mud, as contrasted with actual solution. The direct influence of the infesting animal organisms in bringing about the solution of the calcareous skeleton seems much less than that of the ever-present and ever-active, though less obvious, corroding algæ. Once a coral is attacked

by these, the growth of the ramifying filaments apparently never ceases so long as the necessary conditions of plant life remain; even when the dead coral is broken up into fragments the growing filaments still continue their corroding action on the separate particles, and by the production of soluble bicarbonates lead to their ultimate disappearance.

In the sand found around the small coral islands outside Kingston Harbor, Jamaica, and also on the coral flats, I have often observed the comparative scarceness of fragments or particles which can be referred to actual corals. It appears to be composed largely of fragments of shells of molluscs, spines and plates of echinoids, and nullipores. The greater porosity of corals, along with the attacks of the boring algæ, are probably the causes leading to their more rapid disappearance by solution. On dissolving small quantities of coral sand in acid the whole of the inorganic matter disappears and organic débris only remains. Among this the filaments of the coral-boring algæ, still bearing chlorophyll, are sometimes found, so that evidently the parasites may continue their corroding activity when the host is reduced to coarse particles. Prof. Sollas (Nat. Science, Vol. XIV, p. 27, 1899) found the coral sand taken from the shores of the lagoon of the atoll Funafuti to contain scarcely any coral, but to be composed almost entirely of the shells of Foraminifera. He also observes that from specimens collected on other atolls by the late Prof. Moseley it would appear that the sand of Funafuti is by no means singular in this respect.

The explanation of the origin of coral atolls associated with the name of Sir John Murray rests upon the fact that there has been a constant progress outwards of the actively growing margin of the reef, followed by solution of the internal coral left behind, the disappearance of the coral leading to the formation and the deepening of the lagoon. Murray (Proc. Roy. Soc. Edin., Vol. XVII, p. 79, 1890) has supported his theory of the solution of coral by the carbonic acid in sea-water by laboratory experiments, and most writers on the subject are prepared to accept a slight solubility of coral by this means. So far as the production of lagoons is concerned

Bourne (Proc. Roy. Soc., Vol. XLIII, 1888) doubts if this solubility of coral in sea-water is more than sufficient to counterbalance the effect of the redeposition of lime and the additions from the actual colonies still living within the lagoon.

It is just in such quiet spots as lagoons that the various boring algæ would be expected to grow most favorably, and by their incessant ramifications lead to the ultimate disintegration of any block of coral, following it even when reduced to fragments. The formation of an atoll is without doubt a very complex matter, and many and varied agencies are therein concerned, the destructive forces at one time predominating and the accumulative at another. All that is here contended for is that coral-boring algæ are important factors which must be taken into account in considering the causes of the destruction and disappearance of the older corals as the newer growth progresses outwardly.

As a result of the elaborate investigations carried on by Prof. Alexander Agassiz for the past fifteen years, embracing all the principal coral-reef areas of the world, it is becoming manifest that coral formations are but comparatively superficial in character; apparently they never assume the great thicknesses which have frequently been ascribed to them on imperfect data. Only under special circumstances, as where accumulations of sediment are taking place, do coral masses become permanently preserved; under ordinary conditions they are disintegrated and returned to the sea in a soluble form, or redeposited elsewhere either interstitially or as a cementing material. Here, again, there is no doubt that the corrosive action of boring algæ constitutes one of the most important factors in the resolution of the calcareous skeletons.

The above results having been brought to the notice of Prof. A. Agassiz, he has very kindly sent me his observations on the same subject and permitted their publication in the present connection:

"At the time Duncan published his paper I took up the subject with Mr. Pourtalès enough to satisfy ourselves that boring algæ played a prominent part in the disintegrating effect of corals, and I have not failed to notice the existence of these

parasitic vegetable organisms in the coral reefs I have visited, but without making closer examinations of them. I have frequently noticed their presence in the so-called broken corals (which are, rather, rotten fragments) dredged up from below the depths at which corals live, and have taken it for granted that both rotten corals and so-called broken shells are reduced to that state by the action of parasitic boring algæ.

"The absence of fragments of corals on the lagoon beaches of atolls is due not wholly to solution but to the absence of corals in lagoons as compared to their presence on beaches on the sea-faces; and the absence of corals in lagoons is not wholly due to solution but to the adverse conditions for their excessive growth existing in the lagoons of atolls. This absence of fragments of corals is perhaps best seen at the Bermudas and Bahamas, where the sands of the lagoon beaches are almost wholly made up of broken shells, Foraminifera, etc. The same is the case with many of the atolls of the Pacific."

EXPLANATION OF PLATE XXXII.

Fig. 1. Isolated filaments of the non-septate green alga from the corallum of *Colpophyllia gyrosa* Edw. & Haime. The filaments are full of chlorophyll granules, and the small portion to the right is in an actively growing condition with distinct pyrenoids.

Fig. 2. Different forms of reproductive bodies (Sporangia?) occurring on the non-septate green alga.

a. From *Porites antræoides* Lamarck.

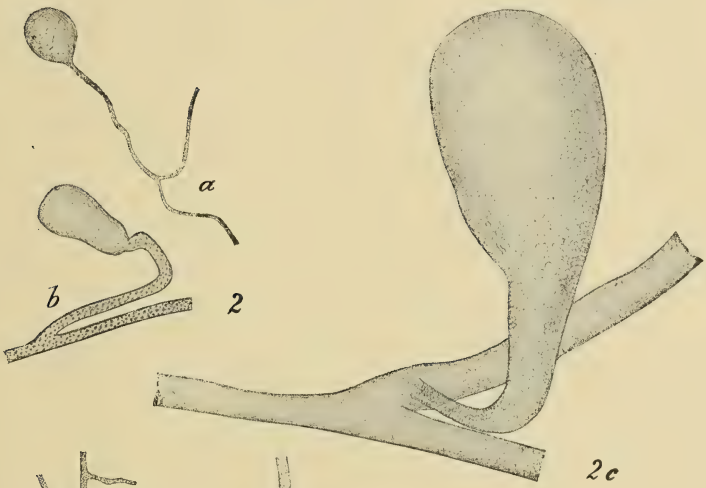
b. From *Colpophyllia gyrosa* Edw. & Haime.

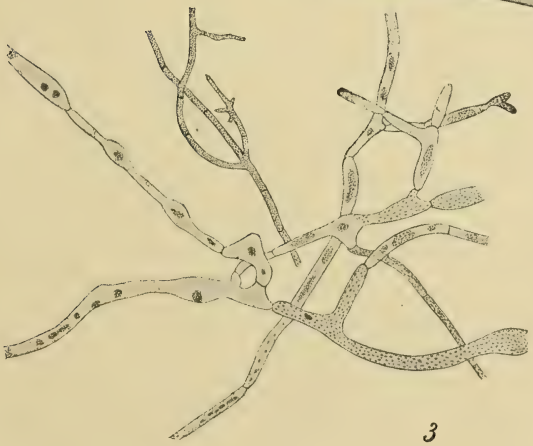
c. From *Stephanocœnia intersepta* (Esper).

The spores are not yet evident in *a* and *b*, but in *c*, which is enormously larger than the others, they are fully ripe and ready to separate. Oval-shaped bodies, apparently differing in no respect from those in the sporangia, occur in the enlarged filaments in *c*, so that no sharp line of distinction between the reproductive capsule and the filament from which it arises can be established.

Fig. 3. Isolated filaments of the septate green alga from the corallum of *Manicina areolata* Linn. The chlorophyll granules occupy the whole surface of the filaments in some places, while in others they are shrunk into isolated aggregations.

Fig. 4. Isolated portions of filaments of a red alga from the corallum of *Porites astræoides* Lamarck.





Coral Boring Algæ.

Photograph by C. E. Taylor. La Soufrière, St. Vincent, from Richmond Estate. *Frontispiece.*

EXPLANATION OF PLATE XXXIII. (Frontispiece.)

La Soufrière, St. Vincent, from the southwest, showing the steep bluffs on the coast due to landslides, and the coating of dust over the surface. The bay in the foreground is the mouth of the Wallibou River, and the bluff on the farther side of it shows the old deltal plain, surmounted by the light-colored deposit due to the present eruption. The surface of this, for a depth of 8 or 10 inches, is darker than the lower part, because it is wet. The remains of Wallibou factory are in the middle of this view. A nearer view of these ruins is shown in Plate XXXVII. See page 340.

Article XXVI. — MARTINIQUE AND ST. VINCENT; A PRELIMINARY REPORT UPON THE ERUPTIONS OF 1902.

By Edmund Otis Hovey.

Plates XXXIII–LI.[1]

Introduction.

On May 9, 1902, the civilized world was startled by the news that a great eruption of Mt. Pelée on the island of Martinique had taken place the preceding day. On May 10 this news was confirmed with the addition of details regarding the annihilation of St. Pierre, the largest and most beautiful city in the Lesser Antilles, and the dispatches also contained the information that on Wednesday, May 7, the volcano known as La Soufrière on St. Vincent had suffered a great eruption attended by much loss of human life and property. Scientific interest in the West Indian volcanoes was of course at once aroused, and geographers and geologists desired to study the phenomena connected with such eruptions. Mr. Morris K. Jesup, president of the American Museum of Natural History, perceived the value of the opportunity, laid the matter before the trustees of the institution immediately, and it was decided to send the author to the islands as the representative of the Museum. Passage was secured for me upon the United States cruiser 'Dixie,' sailing from New York May 14 with supplies for the impoverished inhabitants of the devastated islands, and I arrived at Martinique May 21. The following pages constitute a preliminary report upon the observations made during the period of almost seven weeks, from May 21 to July 6, 1902, inclusive, which I spent upon the islands. About three weeks of this time was devoted to the study of the Soufrière and about four weeks to Mt. Pelée.

From May 21 to 28 I kept my headquarters on board the

[1] Except as noted, the illustrations accompanying this article have been made from photographs taken for the Museum by the author.

'Dixie' and made excursions to St. Pierre and along both sides of St. Vincent in company with the other geologists, viz.: Prof. I. C. Russell, Dr. T. A. Jaggar, Jr., and Messrs. R. T. Hill and G. C. Curtis, who were fellow passengers on the 'Dixie.' At Martinique we were transported by the U. S. tug 'Potomac,' while at St. Vincent we were taken about by the Royal Mail steamer 'Wear,' which had been chartered by the Colonial Government for the purpose of distributing relief supplies. Here I wish to record my appreciation of the hospitality accorded me by Captain R. M. Berry, U. S. N., and other officers of the 'Dixie.' Furthermore, my work on St. Vincent was greatly facilitated by the intelligent activity of Mr. F. W. Griffith, government clerk, Kingstown, acting under general instructions from Sir Robert Llewellyn, C.M.G., Governor of the colony, and by the assistance of T. MacGregor MacDonald, Esq., a planter. Some of Mr. MacDonald's estates, especially the Windsor Forest estate northwest of the volcano, were destroyed by the eruption of the Soufrière, and his notes made during the progress of the great eruption of May 7 record the observations of a calm eye-witness and are of especial value to a student of the event.[1] James E. Richards, Esq., merchant, of Kingstown, gave very practical proof of his hospitality by placing at the disposal of my colleagues and myself his cottage at Petit Bordel, on the leeward (west) side of the island near Chateaubelair, from which there was an unobstructed view of the volcano. It would be impracticable to mention by name all who assisted me in one way or another, for the people were very hospitable. As to Martinique, my letter of introduction to the governor, M. G. L'Heurre, from M. Bruwaert, French consul general in New York, led that official to write a letter to the civil authorities of the colony, which proved to be all that could have been desired for obtaining any help or information which it was in the power of

[1] Mr. MacDonald's notes were published in full in the Kingstown 'Sentry' of May 16, 1902. They have been published also in the 'Century Magazine' for August, 1902, Vol. LXIV., pp. 638–642. The compiler of the latter account in his preliminary notes has confounded the Richmond Vale estate with the Richmond estate. Mr. MacDonald, fortunately, does not own the Richmond estate, which lies between Richmond and Wallibou Rivers and was destroyed by the eruption. The Richmond Vale estate belongs to the MacDonald brothers and was not seriously injured. The house is half a mile northeast of Chateaubelair.

the officials to furnish. The mayors of Fort de France, Carbet, Ste. Marie, and Basse Pointe, and the mayors' deputies at Morne Rouge and Grand Rivière, were of particular assistance; also the attentions of M. Marsau of the mayor's office, Fort de France, and the librarian of the Schoelcher library should be mentioned.

During the night of May 28 the 'Dixie' sailed from St. Vincent, leaving me, in company with Dr. T. A. Jaggar, Jr., of Harvard University, and George Carroll Curtis, of the United States Geological Survey, to prosecute studies on St. Vincent before taking up in detail the investigation of the volcanic phenomena of Martinique. On June 5 Dr. Jaggar left the party and did not again join us in field work, and from that date onward Mr. Curtis and I worked conjointly in obtaining field data. In this Preliminary Report the phenomena observed on St. Vincent receive treatment first, partly because they were studied first, but more because they furnished a satisfactory explanation of some of the phenomena observed on Martinique which, otherwise, would have been difficult to understand. Extended arguments and the elaboration of many interesting details, together with the results of microscopical and chemical studies yet to be made on the ejecta of the eruptions of both volcanoes, are left for my final Report. The maps accompanying this Report, Plates XXXIV and XXXV, have been prepared from the British Admiralty charts and have been reduced to the same scale, for convenience of comparison. In each map the area of most serious present devastation (May and June, 1902) is indicated by cross-lining. The principal routes traversed by the author are shown by the red lines upon the maps.

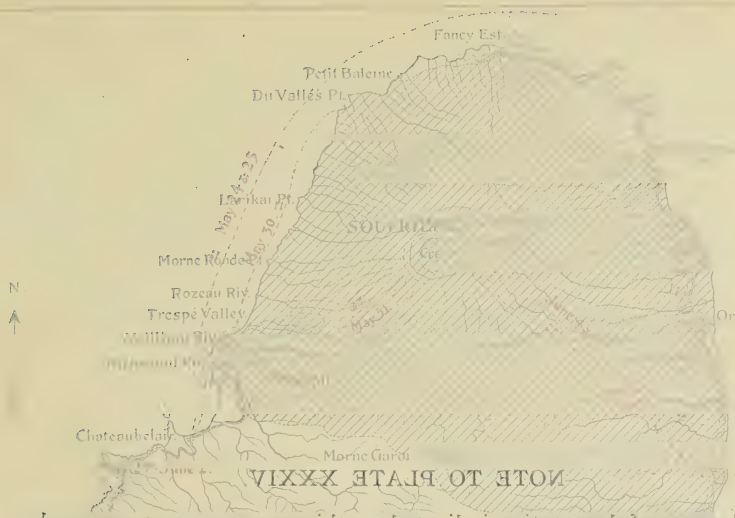
The Soufrière.

The first ascent of the Soufrière, since the eruption of May 7, 1902, was made on Saturday, May 31, by Messrs. Jaggar, Curtis, MacDonald, and myself with six porters. We went up from the site of Wallibou village, on the leeward (west) side, following the remains of the old trail to the rim of the crater at 2790 feet above the sea, an elevation obtained by taking

the mean of the readings of three aneroid barometers.[1] We found the crater probably unchanged in diameter, as nearly as Mr. MacDonald could tell, and therefore to be about nine-tenths of a mile in diameter from east to west and eight-tenths of a mile from north to south, judging from measurements made on the map. The beautiful crater lake, for which the Soufrière was famous before the eruption, had disappeared of course, but there was a small lake of boiling water in the bottom of the pit, from the southeastern quarter of which steam was ascending in a strong column (see Pl. XXXVII). This column at intervals was carrying up quantities of black sand with it to moderate heights above the bottom of the crater. We estimated the surface of the boiling lake to be about 1600 feet below the point on which we were standing, and 2400 feet below the highest point of the rim. The lake seemed to be shallow, judging from some nearly flat ground in the bottom of the crater northeast of the water. Our estimate would indicate that the surface of the water was 1200 feet above the sea. The surface of the old crater lake was 1930 feet (chart) above tide. Its depth in the centre was 87½ fathoms, according to the statements of P. F. Huggins, engineer, of Kingstown, St. Vincent, who told me that he sounded it in 1896. His line was too short to reach bottom in the northwestern part of the lake.

Almost directly opposite the point where we first reached the rim was the wall and saddle between the 'Old' crater and the crater of 1812, apparently unbroken by the eruption. From the lower third of this series of nearly vertical rock-faces and agglomerate beds there issued a strong stream of water which cascaded down the precipices and flowed across a rather narrow strip of nearly level ground in the bottom of the crater and emptied into the boiling lake. It seemed as if this stream must be the discharge of the waters now collecting in the crater of 1812, where there was a little lake before the eruption of the present year. The western side of the crater rim showed a gash leading into the Larakai valley, but the bottom

[1] All the altitudes recorded in this article were obtained by means of aneroid barometers, except as otherwise stated in the text.



MAP OF THE ISLAND OF ST. VINCENT.

Cross-lined area shows approximately the area devastated by the eruption. The lines in red show the principal routes traversed by the author.

NOTE TO PLATE XXXIV.

The area of devastation indicated on this map represents as nearly as practicable the condition of affairs produced by the eruptions of La Soufrière in May, 1902. The outburst of September 3 is reported to have extended considerably the area of present ruin, especially on the western side of the island. The cable dispatches report that the estates of Richmond Vale, Sharps, Petit Bordel, Cull's (= Swan's?) Hill, Tramaka, and Cumberland have been destroyed, while a private letter informs the author that much volcanic sand fell as far as Peter's Hope, five miles south of Chateaubelair. On the leeward side of the island, therefore, the boundary line of the devastated area probably should be placed about three miles south of its location on this map. Sufficient data are not at hand yet for entire revision of the map.

September 15, 1902.

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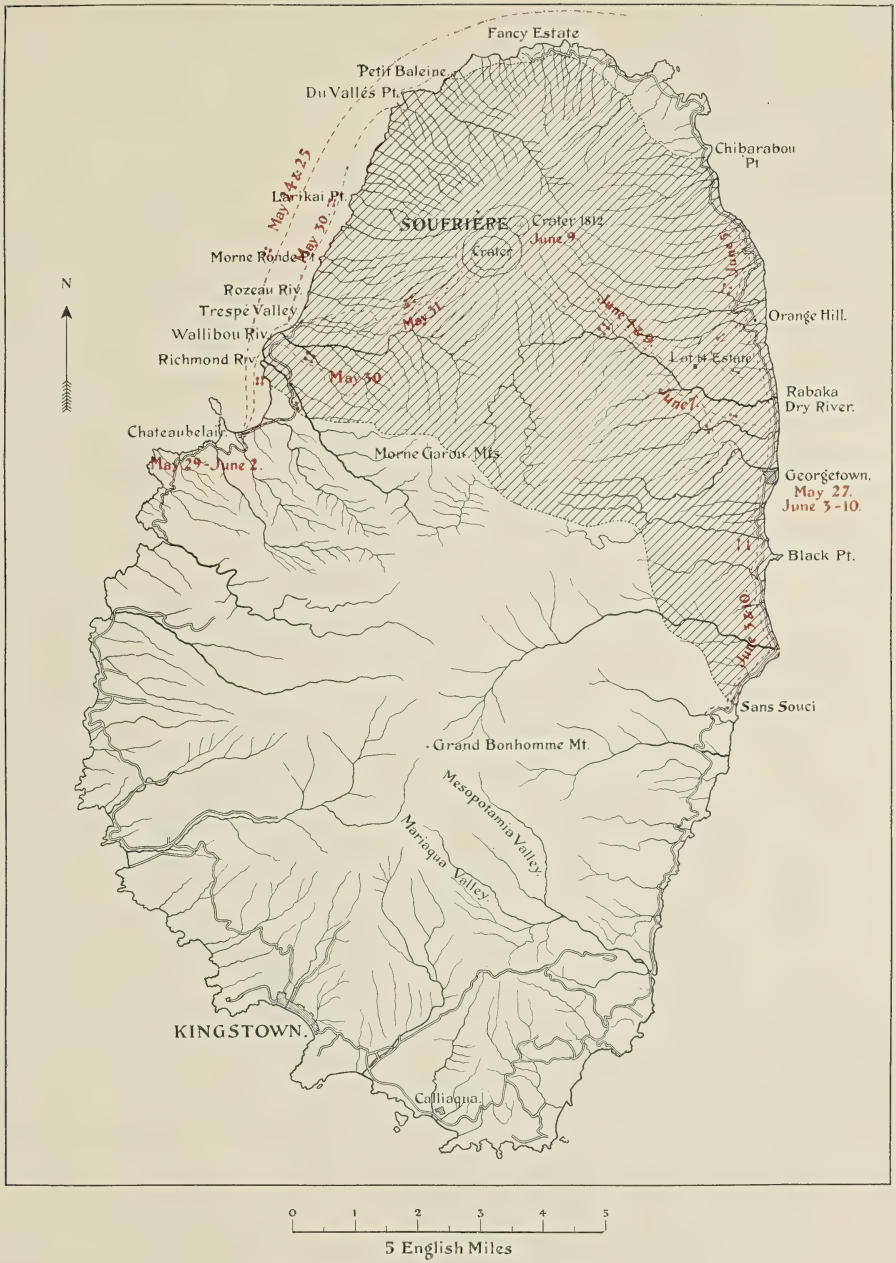


Map of the Island of St. Vincent.

The cross-lined area shows approximately the area devastated by the eruption. The lines in red show the principal routes traversed by the author.

of the gash was more than a thousand feet above the bottom of the crater. Mr. MacDonald said that the gash was there before the eruption took place, but that it seemed to him to have increased in size since the outbursts began. The gash is very much smaller than that in the southwest side of Mt. Pelée, and it does not seem to have had any appreciable, or, better, any determinable, effect in concentrating the force of Soufrière's volcanic hurricanes. Tremendous avalanches of rocks and earth descended the inner precipitous slopes of the crater at intervals during our stay on the rim. They made a great deal of noise, and probably occasioned some of the 'groaning' of the volcano reported by the islanders.

On June 4 Messrs. Jaggar, Curtis, and I made an attempt at the ascent from the windward side. We reached the altitude of 3200 feet, but turned back without getting to the crater itself, on account of dense storm clouds. On June 9 Mr. Curtis and I made our third ascent, alone, except for one guide, and reached the rim of the crater on the southeastern side two or three hundred yards beyond the spot at which we had turned back on the preceding occasion. For fifteen or twenty yards back from the edge of the rim there were crevices in the ground many yards long and up to three inches wide, which formed lenses with the edge itself and indicated the imminence of landslides into the crater. We pushed along the rim northward, until, at an altitude of 3550 feet above the sea, we stood between the large crater and the crater of 1812. The summit of the Soufrière east of the large crater and south of the small one is formed by a rather small plateau which slopes gently toward the southeast, closely analogous in position to the small plateau on the eastern summit of Mt. Pelée which was the site of the Lac des Palmistes. This plateau was covered with a bed of dust, lapilli (= volcanic sand and gravel), and boulders which was ten to fifteen feet thick in places, and the trenches cut by recent rains made travelling very laborious, except near the edge of the crater.

In spite of clouds and rain, this visit, through occasional glimpses of the interior, enabled me to determine that the crater of 1812, which for nearly a century has gone by the

name of the 'New' crater, took no active part in the eruptions of May of the present year, a conclusion based on the following considerations: the saddle between the two craters appeared to be intact, confirming the observation made from the other side of the large crater; a knife-edge ridge which ran at a steep incline from the saddle to the bottom of the small crater and formed the pathway for descent into it before the eruption was still there, and had on its slopes bare trunks of trees standing; in the bottom of the crater along the base of this ridge we could see talus slopes of dry (?) dust and lapilli which had slid and rolled down its sides; although the roaring of the steam and boiling water nearly half a mile below us in the large crater was obtrusively discernible, no sound whatever came from within the crater of 1812; the rim of the small crater showed less and less dust as one receded from the edge of the great crater. Samuel Brown, a ranger, or caretaker, on the Lot 14 estate on the southeast slopes of the Soufrière, who was our guide when we reached the small crater, told us that he watched the eruption of May 7 until the great outburst at two o'clock and that no cloud of steam or 'smoke' rose from the small crater. Furthermore, at the time of my leaving the island, June 10, no column of steam had risen above that crater since May 7. Brown was at the sugar factory of the estate, three and one-half miles in a straight line east-southeast from the crater, a most favorable spot from which to observe what was going on at the summit of the mountain. He saved his life by running into the rum cellar of the factory and closing the door and the window shutters just before the volcanic blast swept over the building. On inquiry in Georgetown I found persons who had watched the eruption from the town and had noted the fact that no column of steam rose from the small crater.

The Soufrière, and, in fact, the whole of the island of St. Vincent, is made up of ancient lava flows alternating with volcanic fragmental deposits or tuffs.[1] These tuffs consist of boulders of all sizes imbedded in a matrix of coarse and fine gravel and sand, the whole being compacted into a rather soft

[1] The alternation of lava beds and tuffs is illustrated in Figure 2 of Plate XXXVII.

rock, which is known as 'tuff agglomerate' or merely 'agglomerate.' These ancient agglomerates show that there have been many eruptions of the volcanoes of St. Vincent of the same character as that of 1902. They contain bombs as well as blocks. The beds of solid rock on the island show that many of the ancient eruptions were accompanied by extensive flows of molten lava. The porous agglomerates have suffered much from the decomposing action of percolating waters, and the lava beds show extensive alteration due to the same agency. Beautiful spheroidal weathering is common in the basalts of the southeastern part of the island and in the elevated beach conglomerates of the windward coast.

Although there are many ancient lava beds in the composition of the mountain, no *stream* of melted lava has issued from the Soufrière during the present eruption. The 'bread-crust' bombs, however, which occur plentifully on the mountain sides, especially on the windward slopes, show that during the present eruption molten lava has been present in the throat of the volcano, and that many lumps of melted or half-melted rock were thrown into the air. Besides the bombs, the volcano ejected blocks of ancient andesitic lava of several kinds and of varying degrees of coarseness of grain, and of all sizes up to masses six or eight feet across, and vast quantities of coarse and fine lapilli and dust. Most, if not all, of the blocks were thrown out at high temperatures, as is shown by their cracked condition, though they were not actually fused. Although a few bombs, some of which were twelve to fifteen inches across, were found on the leeward side as far away from the crater as the site of Richmond village, three and one-half miles from the crater, by far the largest number of both bombs and blocks, as well as the largest specimens, were found on the windward side, bombs fifteen to eighteen inches in diameter being common in the bed of the Rabaka Dry River. The proportion of old lavas in the ejecta of the Soufrière seems greater than in those of Pelée, and there is greater variety, apparently, in their composition.

The area of devastation on St. Vincent is very large in proportion to the total area of the island. After plotting it out

carefully on the British Admiralty chart and measuring the area with a planimeter, I find it to be forty-six square miles, practically one-third the entire area of the island. From much of this devastated area, however, the ashes are being washed off so rapidly by the rain that vegetation is already asserting itself and within another year crops will be growing there again.

Extensive landslides have taken place on the western side (see Pll. XXXIII and XXXVIII), removing a strip of coast, in places one hundred yards wide, continuously from the mouth of the Wallibou River to Morne Ronde village, a mile and a half to the north, and at intervals for two miles farther north. These landslides have left precipitous walls along the shoreline, and deep water is found where villages stood and prosperous plantations existed before the eruption. We had no sounding line, but our boatmen could not touch bottom with a twelve-foot oar three feet from shore on the site of Morne Ronde village. The sections left by the slides show that the land which has disappeared consisted of delta and coast-plain deposits, material which would be dislodged easily from the more substantial lava flows and agglomerate beds by the vibrations due to the eruptions. The eastern, or windward, side of the island is not nearly as steep as the leeward, and landslides have not occurred there as features of this eruption. On the contrary, the windward shoreline from Black Point, a mile south of Georgetown, northward almost to Chibarabou Point, more than six miles distant, has been pushed out by the vast quantities of fresh lapilli which have been brought down from the slopes of the volcano by the rivers and the heavy rains, during and since the eruptions, and distributed by the ocean currents.

A large amount of material, too, was brought down by the Rabaka Dry River an hour in advance of the great outburst of May 7, which seems to have been due to the bodily discharge of a portion, at least, of the old crater lake into the headwaters of that stream. Survivors who attempted to cross the Rabaka Dry River toward noon of that day report that they were prevented by a torrent of 'boiling hot' water and mud rush-

ing down the valley and that a wall of water and mud fifty or more feet high (they compared it with the height of a factory chimney) came out of the upper reaches of the river and swept out to sea. There was no heavy rain that day before the eruption took place, but the lake still was in the crater early in the day, according to the tale of a fish-woman who had ascended the mountain from Georgetown that morning on her way home to Chateaubelair. The trail led along the rim of the crater for half a mile. The woman reached the rim at nine o'clock and found that fissures had appeared in the ground and that the lake was at a higher level than usual and boiling. She rushed back to Georgetown to warn the people, but her tale was discredited. Mr. MacDonald's notes contain the entries: "12.55 P.M. Enormous discharge to windward side, color darker. 1 P.M. Tremendous roaring, stones thrown out to windward thousands of feet."[1] While this does not *prove* the bodily outthrow of the lake, it shows that there was a great outburst from the crater just in advance of the flood in the Dry River valley.

It is evident that there was a blast or a series of blasts of hurricane violence from the crater of the Soufrière as well as from that of Mt. Pelée, as a feature of the eruptions of 1902. The effects were not so appalling, however, on St. Vincent as on Martinique, because no large city was destroyed there. The overturned trees constitute the principal evidence on the island of St. Vincent. They all point away from the crater, except for slight modifications due to local topography (see Pl. XXXIX, Fig. 2). The blasts extended radially in all directions from the crater, suggesting the explanation that great volumes of steam, rising from the throat of the volcano, could not find room for expansion upward, on account of the column of steam and ashes which had preceded them, and the ashes falling therefrom, and that they expanded with explosive violence horizontally and downward, following the configuration of the mountain. This accords with the testimony of Mr. MacDonald and other eye-witnesses of the eruptions, who say that they saw the clouds of 'smoke' (dust-laden steam)

[1] Century Magazine, Vol. LXIV, p. 639. August, 1902.

rushing down the sides of the mountain with terrific speed. This dust-laden steam was able to do much work of erosion, as is shown by the horizontally scoured sides of some of the exposed cliffs and by the trunks and roots of overturned trees. The roots particularly have been charred by the heat and carved into fantastic, pointed shapes, as if they had been subjected to the action of a powerful sand-blast. As already stated, the disposition of the roots and trunks clearly indicates the crater as the source of the blast. Erosion has not materially affected the original surface of the ground as yet, because almost everywhere one can find the living roots and charred blades of grass and other vegetation beneath the covering of dust and lapilli, the first of which acted as a protection against the heat of the rest. The erosive action now, however, is that the heavy rains take up vast quantities of the loose lapilli for use as a powerful scouring agent in attacking the denuded hillsides, and thus old valleys are being deepened and widened.

The particular feature of the eruption of the Soufrière was the enormous amount of dust which was thrown into the air and distributed over a vast, somewhat elliptical area, the extent of which cannot yet be calculated for lack of data. The British steamship 'Coya' had an eighth of an inch of volcanic dust from this volcano fall on her deck when she was two hundred seventy-five miles east-southeast of St. Vincent. The steamer encountered the dust at 10.30 P.M., May 7, eight and one-half hours after the eruption of the Soufrière began, indicating transport against the prevailing wind at more than thirty-two knots per hour. Reports of vessels from the west (leeward) of the island have not come to my notice, but the statements of the islanders would indicate that the greater proportion of the cloud of dust went to the east and southeast. The dust was spread like a gray mantle over the island, generally diminishing in thickness from the crater outwards, but collected in vast deposits in certain valleys on the sides of the mountain, where the conditions seem to have been particularly favorable. The chief of these beds were formed in the Wallibou, Trespé and Rozeau valleys on the leeward (west) side, and in the valleys of the Ra-

baka Dry River and its tributaries on the windward (east) slope, with by far the greatest thickness along the Wallibou and Rabaka Dry Rivers. In the valley of the Wallibou the deposits were not less than sixty feet deep in places, while in the Rabaka Dry River the fresh material filled a gorge which is said to have been two hundred feet deep before the eruptions began (see Pl. XXXIX, Fig. 1). From a distance this deposit looks as if it were a glacier coming out of the mountains.

Such great accumulations of hot lapilli and dust retain their heat for a long time and they have given rise to secondary, or superficial, eruption phenomena of striking character and considerable interest. The river water and the water from the tropical showers percolating through the beds have come into contact with the still highly heated interior, causing violent outbursts of dust-laden steam. We saw one of these outbursts from the Wallibou valley send up a column of such vapor fully a mile in height. The action lasted for nearly an hour. The secondary eruptions illustrated by the figures on Plate XL took place on a clear, dry morning and must have been caused by the percolating river waters. On May 30 we witnessed the throwing of a dam across the stream and the formation of a temporary lake by a heavy secondary outburst of dust-laden steam from the lapilli-bed in the Wallibou valley. This eruption is illustrated in figure 2 of plate XL. After the eruption ceased, the little lake soon rose to the top of the dam and quickly cut its way down to the old level, sending a 'mud-flow' down the gorge to the sea. Such a lake in the valley of the Rabaka Dry River cut its new outlet through a narrow ridge of the old agglomerate constituting the wall of the cañon, forming as it did so a beautiful series of channel-bowls, pot-holes and scratched corkscrew channels.

When we first reached St. Vincent, the dust, especially that covering the Richmond estate, showed in marked manner the wind-drift surface so familiar in the case of freshly fallen snow, and in many places these drifts were from three to four feet deep (see Pl. XLI). There were several heavy rains between May 24 and 29, so that the appearance of the surface was very different on May 30 from what it was when I first saw it. Its

drifted character was not nearly as evident and the beautiful dendritic drainage, which was already in evidence on May 24, had been greatly extended and intensified (see Pl. XLII). Geological operations, which under ordinary conditions are so slowly performed as to be imperceptible, were being carried forward rapidly under our very eyes. One item of interest was the action of the Wallibou River itself as it cut into and undermined the beds of dust and lapilli along its banks. Its waters became so overloaded with sediment that they could only flow in pulsations, showing that intervals of time were needed by the stream to gather strength to force its way along with its burden. On May 24 these waves or pulsations were from fifteen to forty seconds apart. Such mud streams carry large boulders down their beds and have great erosive power.

When the great cloud of ejecta rose from the Soufrière at 2 P.M., May 7, the portion which was traveling eastward seemed suddenly to split, according to the accounts of eyewitnesses, when it was some distance beyond the island, and to send a part back to the land. This is in accord with the fact that unprotected windows in the eastern side (that farthest from the crater) of houses in the devastated district along the windward coast were all stripped of their glass, while immense quantities of dust were carried to the island of Barbados, 90 miles due east, and beyond.

An official estimate of the loss of life on St. Vincent by the eruption places the number of killed at 1350. The actual number of bodies buried was 1298, including those of the wounded who died in the hospitals. Almost all of the people who passed through the fury of the eruption and escaped uninjured had taken refuge in cellars the only openings into which were on the side farthest from the crater and were, moreover, tightly closed with wooden doors or shutters. The most striking example of such protection was at Orange Hill, on the windward coast, two and one-half miles north of Georgetown, where one hundred thirty-two persons were saved unharmed in an empty rum cellar. This cellar, which is only partly underground, is part of a sugar factory

situated on a rather flat divide between two ravines which may have tended to separate the volcanic storm somewhat, though the roof of the building over the cellar was demolished by the ejecta. The only openings into the cellar were a door and two windows on the side opposite the crater, and these were provided with heavy wooden shutters which were kept closed during the fury of the eruption. The experiences of the people in these cellars suggest the great desirability of constructing similar places of refuge for use in time of hurricane as well as of volcanic eruption.

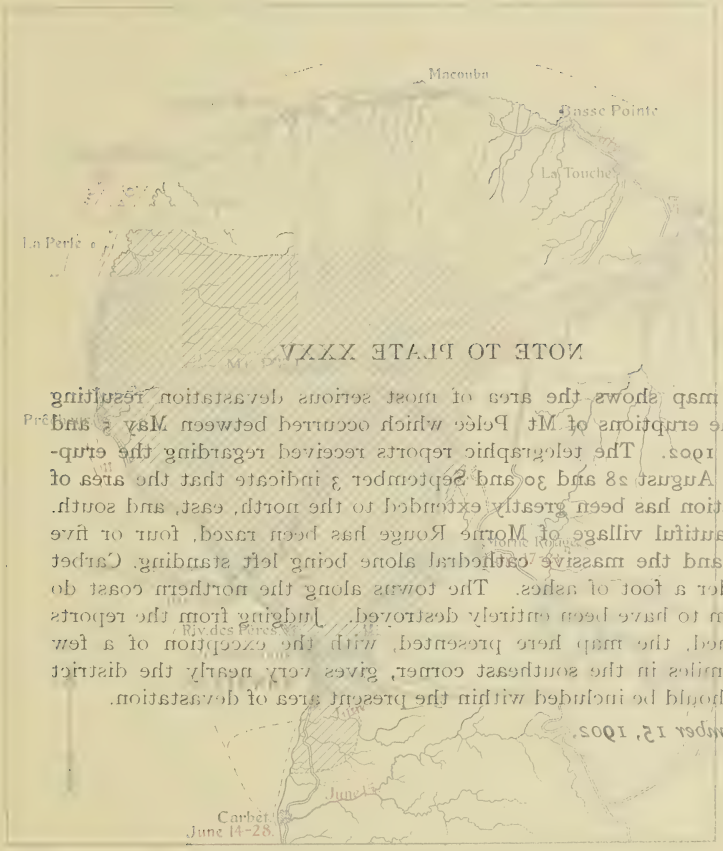
The deaths on St. Vincent seem to have been due, principally, to the following causes: (1) asphyxiation by hot, dust-laden steam and air, (2) burns due to hot stones, lapilli and dust, (3) blows by falling stones, (4) nervous shock, (5) burning by steam alone, and (6) strokes of lightning. The last mentioned cause is perhaps somewhat doubtful, for though it is very generally named by the survivors, there has been no substantiation mentioned beyond the fact that there was a great deal of extremely vivid lightning during the eruption. The action of steam may account for burns received underneath the clothing where the clothing was not even charred. Sulphur dioxide, SO_2, and hydrogen sulphide, H_2S, were observed in troublesome quantities in the steam coming from the crater, and it is more than probable that these gases, especially the former, added very materially to the deadly character of the dust-laden steam. Strange as it may seem, not an autopsy was made on any of the hundreds of victims of the catastrophe, so that it never can be known definitely what part was played by these or other poisonous gases in the destruction of human life.

Mt. Pelée.

The destruction of human life overshadows every other consideration, in popular estimation, at least, when one speaks of the eruption of Mt. Pelée which took place May 8, 1902. The sweeping of between twenty-five and thirty thousand human beings out of existence almost in a moment presents a holocaust with but few parallels in the history of the world.

The eruptions of Krakatoa, Tomboro and Bandai San and the Lisbon earthquake of 1755 come to mind as natural catastrophes of even greater destructiveness to life, but nothing has occurred within a century which has so stirred the civilized world as has the annihilation of the beautiful city of St. Pierre, the "pearl of the Lesser Antilles." The present eruptions of Pelée and the Soufrière will not, however, take first rank among those which have torn these and other Caribbean volcanoes, but they are extensive enough and are of such a character as to merit the study they have been and are receiving. Perhaps these eruptions, too, will add something to the world's knowledge of the science of vulcanology.

The area of devastation caused by this eruption of Pelée is less than that due to that of La Soufrière (compare maps, Pll. XXXIV and XXXV). Plotting the area on the Admiralty chart as well as possible, after inspecting all sides of the volcano, and measuring it with a planimeter, I find that thirty-two square miles of Martinique were laid waste by dust, lapilli, stones and 'mud.' The area is not as symmetrically disposed about the crater as is the case on St. Vincent, probably because the crater of Pelée is so much lower on the southwest than on the other sides and the great gash opening into the gorge of the Rivière Blanche, together with the configuration of the neighboring 'mornes,' or ridges, has given direction to all the violent explosions which have occurred. Although the whole island has received débris from some of the outbursts and dust has been scattered over a wide area, the district over which the vegetation was killed, at least temporarily, is included within a line beginning at the sea coast, about midway between St. Pierre and Carbet, though the palm trees along the coast at the base of the bluffs were scorched as far as Carbet Point itself. Passing inland about a mile the line curves sharply to the north and east of north to the Roxelane River, then goes northeastward along this river and one of its tributaries, paralleling the main street of Morne Rouge within a quarter of a mile, swings then to the east of La Calebasse and rises somewhat on the northeastern flanks of Pelée, apparently passing along the south side of Pain de Sucre and



Map of the Northwestern Part of the Island of Martinique

The cross-hatched area shows approximately the area devastated by the eruptions of Mt. Pelée. The arrows show the principal routes traversed by the

NOTE TO PLATE XXXV

This map shows the area of most serious devastation resulting from the eruptions of Mt. Pelée which occurred between May 5 and July 6, 1902. The telegraphic reports received regarding the eruptions of August 28 and 30 and September 3 indicate that the area of devastation has been greatly extended to the north, east, and south. The beautiful village of Morne Rouge has been razed, four or five houses and the massive cathedral alone being left standing. Carbet lies under a foot of ashes. The towns along the northern coast do not seem to have been entirely destroyed. Judging from the reports mentioned, the map here presented, with the exception of a few square miles in the southeast corner, gives very nearly the district which should be included within the present area of devastation.

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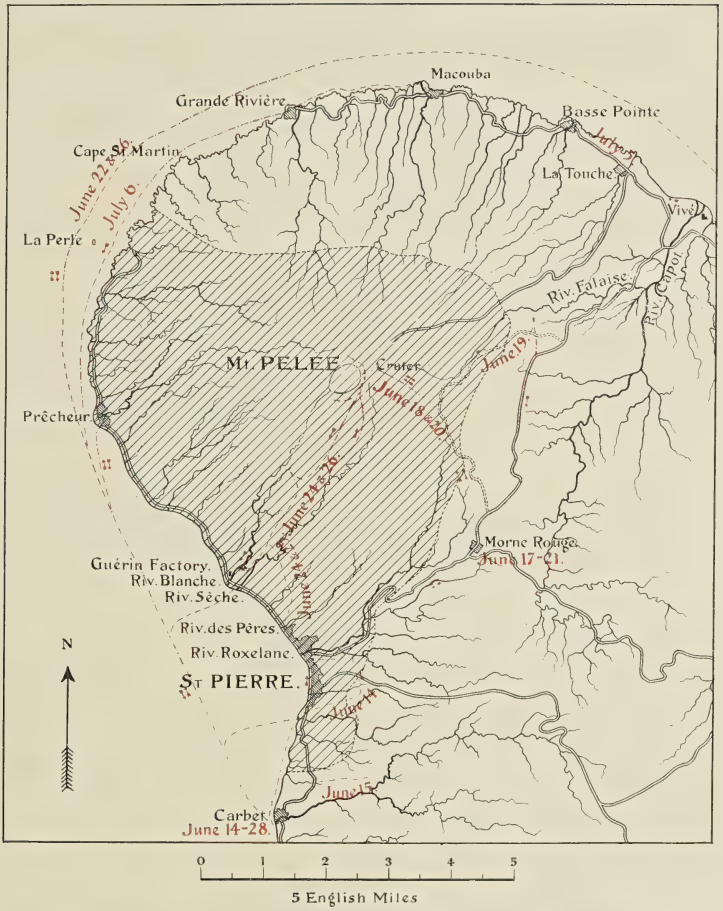


Map of the Northwestern Part of the Island of Martinique.

The cross-lined area shows approximately the area devastated by the eruption. The lines in red show the principal routes traversed by the author.

then northwestward, leaving the island midway between La Perle Rock and Cap St. Martin. Much of this area is already springing into verdure again; the grass was already very noticeable on the hill slopes encircling St. Pierre by July 1, and green vegetation was to be seen even nearer the source of destruction. When we first arrived at Martinique (May 21) the line between the scorched and unscorched areas was strikingly sharp, and was still very noticeable six or seven weeks later. In many places the line of demarkation passed through single trees, leaving one side scorched and brown, while the other side remained as green as if no eruption had occurred.

The material ejected by Pelée during this series of eruptions consists of dust in vast quantities,[1] fine and coarse lapilli, bread-crust bombs (see Pl. LI) of all sizes from one inch to three feet and more across, and blocks of small and great size, the cracked condition of which shows that they have been highly heated. The freshly fallen ashes had a curious resemblance in appearance to snow, which gave a peculiar Alpine aspect to the mountain, and is noticeable in some of the photographs. No *stream* of molten lava has issued yet from the volcano as a feature of this eruption, though such flows were common in the early history of Pelée, as they were in that of St. Vincent's Soufrière. The bread-crust bombs prove, however, that much lava has been thrown out in the condition of melted or half-melted masses. These bombs usually are more or less pumiceous in texture, and they show the 'bread-crust' surface much more distinctly than do the more basic bombs of the Soufrière. The largest of the bombs observed was one fifteen feet long on the southeast slope of Morne Lacroix at an elevation of 3950 feet above the sea. The largest ejected block that we saw was one on the surface of the mud-flow between the rivers Blanche and Sèche and not more than two hundred yards from the sea coast. Its dimensions are about 22 feet high, 30 feet long and 24 feet broad, and it is of the light gray andesitic lava forming one of the ancient lava beds near the summit of the mountain (see

[1] One hundred twenty tons of dust and lapilli were removed from the decks of the 'Roddam' after her arrival in the harbor of Castries, St. Lucia, according to the personal statement of one of the agents of the line to which the steamer belonged.

Pl. XLVIII, Fig. 2). An outcropping bed of rock very similar in appearance to this occurs at an elevation of about 3350 feet in the rim of the present crater, at the side of the great gash in its southwest side. When I inspected this block on June 25, I found it too hot on the surface to bear the hand upon it long at a time, the great mass was cracked in several directions, and steam and sulphurous gases were emanating from the cracks. It seems certain that this enormous block was thrown out of the crater in a highly heated condition during the present eruption, but it may have reached the place where it now is partly through the agency of the great mud-flow on which it rests.[1] Many other great boulders, some of which are of nearly half the dimensions of the one just described, lie near by on this mud plain.

The area of distribution of the ejecta cannot be designated accurately yet for lack of data. The U. S. collier 'Leonidas' received a quarter of an inch of dust on her deck from the great outburst of June 6 when she was 102 miles west of Martinique. It took the ship from 3 P.M. until nearly 6 o'clock to traverse the cloud of dust. This eruption began at 10.15 A.M. and was one of the heaviest of the whole series. I was in Georgetown, St. Vincent, at the time and felt the shock distinctly. From 3 o'clock onward that afternoon until after sunset heavy clouds of dust from the Pelée eruption passed over St. Vincent, much of it falling upon the island. The top of the cloud of dust as it passed over the mountains seemed to me to be about 6000 feet above the sea, so that the last deposits must have been made far south of St. Vincent. The shocks or detonations from some if not all of the great outbursts were felt in St. Kitts and Trinidad, though not in some of the intervening islands.

Two illustrations of the force with which the bombs and blocks strike may be permitted here. On the sea coast near the Fort Villaret church in the portion of St. Pierre north of the Roxelane River there was a large distillery in which there

[1] On seeing my photograph of this great block, Prof. Heilprin told me that he thought that it was not on the plateau at the time of his visit, because he did not see it. Unless it was buried then and has been brought to light since by erosion, the block probably was thrown out of the volcano in the great eruption of June 6.

were four big storage tanks constructed of quarter-inch boiler iron plates riveted together. These tanks (see Pl. XLVII) look as if they had been through a bombardment by artillery, being full of holes which vary in size from mere cracks at the bottom of indentations to great rents 24, 30 and even 36 inches across, while a strip several feet long was torn off from each of two. Most of the holes are irregular in shape, but some are nearly circular, and the cracks are single or intersecting. The direction of impact was essentially the same in all instances, namely, from the crater, and at least two holes, the sides of which were not completely torn open, had stones wedged in them when we examined the place. The other illustration is found on the southeastern flanks of Mt. Pelée, along the trail leading from Morne Rouge to the summit, where numerous elliptical or spoon-shaped depressions occur in the rather loose soil of the mountain side, especially between the elevations of 2400 and 3000 feet above tide. These holes are of all sizes from 2 feet in diameter upward, the largest one which we saw being 40 feet long, twenty-5 feet wide and 5 feet deep, but the depth had evidently been reduced by the sand which had been washed into it by recent rains. The longer axis of this depression was N. 50° W., pointing directly at the crater, and the longer axes of all the other holes observed were pointing toward the same center. The deepest part was on the up-hill side. On the down-hill side of each depression we found the cause of the phenomenon, and it was a bomb or ejected block from the volcano, which had struck the ground with a splash, throwing the earth in all directions and usually bounding or rolling out of the hole which it had made. Sometimes the blocks which did the work were found intact, but sometimes they had burst asunder after striking. All showed that they had come out of the volcano in a highly heated condition. Such splashes as these can be made experimentally on a small scale in any bed of stiff mud by means of well-directed stones.

Many stones must have fallen in St. Pierre, but they are so mingled with the rubble stones from the walls of the ruined buildings that usually they are not easily distinguishable

therefrom (see Pl. XLV). Great quantities of small, rounded fragments of yellow pumice are to be found now amid the ruins, the fine gray dust having been washed away to a considerable extent by the copious rains which have fallen since the great eruptions. Most of the pebbles of pumice were less than three inches in diameter. They are evidently from the old tuff agglomerate and must have been torn from the beds through which the volcanic vents pass and from the interior of the old cone. Stones fell all over the island in some of the eruptions. It is reported that during that of May 20 one weighing two and a quarter kilos (about five pounds)[1] fell through the hatch of the Norwegian bark 'Helga,' which was at anchor in the harbor of Fort de France. The stone is said to have been so hot that it set fire to the soft coal into which it fell.

Four ascents of Mt. Pelée, in the course of which the crater rim was traversed from the great chasm on the southwest along the southern and eastern edge more than two-thirds of the way around the circle, and the remainder also of the rim was clearly seen, enabled us to form a reasonably definite idea of the center of activity and what was going on therein. Twice we followed the trail from Morne Rouge to the summit, which led us for a considerable distance along the right (southern) brink of the cañon of the Falaise River, and on the day intervening between these ascents we examined the gorge of the Falaise carefully from the point where the Morne Rouge trail to the summit strikes it nearly to its junction with the Capot River, a mile or more beyond the area of devastation. The upper reaches of the gorge certainly present the scene of desolation so graphically described by George Kennan,[2] but the 'Falaise crater' mentioned by him and by Professor Heilprin [3] and indicated on Hill's map [4] can hardly be a true crater. We saw the same accumulations of volcanic ash in the gorge at an elevation of 1800 to 2000 feet above the sea (aneroid reading)

[1] It seems probable that the weight was one kilo (= two and one-fifth pounds) and that it was incorrectly reported through confounding metric and English units of weight.

[2] The Outlook, Vol. LXXI, pp. 773, 774. 26 July, 1902.

[3] McClure's Magazine, Vol. XIX, p. 363. August, 1902.

[4] See page 359.

that Heilprin and Kennan mention as forming a crater from which mud-flows were hurled down the gorge to the sea, and we saw steam issuing from them, but to us who had studied the phenomena on St. Vincent it seemed perfectly evident that the outbursts in the gorge of the Falaise were comparatively feeble examples of secondary or superficial eruptions of the same character as those which took place on such a grand scale from the ash-beds of the Wallibou and Rabaka Dry Rivers. Percolating rain or river water caused the hot ash-bed to explode, throwing a loosely aggregated dam across the stream and causing the water to pond back until it obtained sufficient force to break through the obstacle. Then the waters, loaded with volcanic débris from the hillsides and the ash-bed dam, rushed down the gorge, gathering additional material from the walls of old tuff and picking up great boulders in their course, and the load of mud and stones was deposited along the flat land near the mouth of the stream or carried to the sea coast to build out the deltas and the shore-lines. This was the history of events in the Falaise and probably at Basse Pointe, Macouba, Grande Rivière and other places; and it was the history of some, but not all, of the mud-flows in the Prêcheur, the Mare, the Blanche, the Sèche, and the Des Pères rivers. Since the eruptions began there have been great floods in the Roxelane River, but it seems doubtful whether or not this stream has carried any true mud-flows down its gorge.

The actual crater is apparently somewhat oval in shape, with its longer axis stretching northeast and southwest. The highest point of the rim is on the northeast side and is what is left of the peak known as 'Morne Lacroix.'[1] By taking the average between the readings of our two barometers, we

[1] The following quotation from 'Les Colonies' of May 5, as translated in the Century Magazine for August, 1902 (Vol. LXIV., p. 623), seems to show that the name 'Morne Lacroix' applies to the highest peak on the western edge of the crater, and that the highest peak of the eastern rim, the one which Curtis and I determined to be 4200 feet high, is what remains of the Ti-Bolhommes, but I follow the descriptions of Lafcadio Hearn and other travellers in locating Morne Lacroix east of the great crater containing the Étang Sec.

"The guide, M. Julien Romain, who is one of the Morne Pavillot property-holders, went up the mountain ten days ago, after the awakening of the volcano. We reproduce the substance of his interesting account, which was very gracefully related.

"The mountain has for its highest summit Morne Lacroix, and describes a vast circle, the bottom of which measures close upon six hectares [nearly fifteen acres] in surface.

"This circle, which we are now defining according to lines upon the guide's indica-

determined its altitude to be 4200 feet above the sea.[1] It consists of ancient andesitic lava. Almost directly opposite this is the lowest point of the crater, where the great gash formed by the gorge of the Rivière Blanche occurs (see Pl. XLIII, Fig. 2). The lava bed forming what may be considered the rim of the crater on the southeast side of the gash is 3350 feet above tide, while the real bottom of the gorge where it issues from the crater is five or six hundred feet less in altitude. From this lava bed the rim rises rapidly (30° to 35°) to about 3750 feet above tide (see Pl. XLIV, Fig. 1) and then more gradually along the southern edge until 3950 feet is reached on the eastern edge. The northwest side of the southwestern gash is formed by a pinnacle of ancient lava which appears to be about 4000 feet above the sea, but may be higher. From this point the rim drops somewhat toward the north, but gradually rises again toward the east until the point of rock on the northeast, already mentioned, is reached again. This great crater is about half a mile across, an estimate that is based upon the proportion which it bears to the height of the mountain, looked at from the sea, and from the fact that it took us twenty minutes to walk along the southern third of the rim from our first cairn to the Rivière Blanche gorge without stopping. The walking was not bad, considering the location of the route, and I should estimate the distance traveled in this time at not less than half a mile.

The breadth of the rim varies from a mere knife-edge on the south, north and northeast sides to a sloping plateau fifty to one hundred yards wide on the eastern side. This plateau

tions, is limited on the south by Piton Marcel, on the east by the three peaks of Ti-Bolhommes, on the northeast by Morne Pavillon, and on the west by Morne Lacroix.

"The funnel measures, he says, more than thirteen hectares at the opening.

"Étang Sec lies almost in the center of this immense basin.

"Étang Plein [= Lac des Palmistes] is on the other side of the Morne [Lacroix?]

"The crater is on the southern slope of Morne Lacroix, and therefore on this [=St. Pierre] side of Étang Sec.

"This crater, which resembles a great sugar-pan, has nearly the form of a rectangle, thirty meters long and, at the minimum, twenty meters wide.

"In this pan, or rather this oblong caldron, was boiling a singular black mixture resembling bitumen. It rose in little puffs, emitted from time to time jets of white steam and boiling water, then fell back like creole *matété*, or molasses, only to rise again. Étang Sec was acting as a reservoir for the boiling waters escaping from the crater.

"The sources of Rivière Blanche are below, and on the slopes of Ti-Bolhommes."

[1] The French engineers located at Martinique are reported to have determined (by triangulation ?) that Morne Lacroix had lost 150 feet during the eruption, making its present altitude 4273 feet above tide.

is where Heilprin [1] locates the empty basin of the Lac des Palmistes, which was considered to be the old crater lake of Mt. Pelée. Studying this plateau carefully, we saw that it sloped gently southward and eastward from one side of a low divide running northeastward from the highest point of the crater rim across to a high ridge which paralleled the northern and northeastern sides of the crater. On the northwest side of this divide, the altitude of which was 3950 feet above tide, the plateau becomes a shallow valley and rapidly changes into a gorge discharging into the cañon of the Prêcheur River. Heilprin's description and his unpublished photographs show the existence on this plateau of a small lake-basin, and agree with the assertions of his guides as to its position and as to its depth of not more than five or six feet. He and his companion, E. E. Leadbeater, a New York photographer, state, furthermore, that this plateau and this portion of the crater rim were entirely or practically free from ash and dust deposit. When Mr. Curtis and I visited the spot, the great eruption of June 6 had taken place, and the surface was coated with a thick layer (more than four feet deep in places) of dust and ashes. This material had drifted into depressions to such an extent that we saw no indication of the existence of a lake basin in this plateau. We had a perfectly clear and cloudless period when on the spot, and saw the topography with distinctness. I cannot think that the plateau, including the lake basin, ever has been a primary crater or center of eruption, though at the time of my visits the ground was hot, a scalding temperature being reached less than a foot from the surface, and steam was issuing from numerous crevices. This probably was the site of the Lac des Palmistes, but, that lake was not located in the great ancient crater of Mt. Pelée.[2]

Judging from the account of the guide Romain, from the 'Notes relating to the history of the eruption of 1902,' as

[1] *Op. cit.*, p. 360.

[2] The photograph of the Lac des Palmistes published by Dr. Emil Deckert on page 425 of the 'Zeitschrift der Gesellchaft für Erd-kunde zu Berlin' for 1902 shows that body of water as it appeared in the rainy season of 1898. Deckert describes the lake as being but 2 meters deep and as lying in the middle of a morass or swamp upon a bed of lava. He regards this as a crater lake, though he mentions the fact that there is not and probably never could have been any crater wall on the east and north [south] sides. The eastern end of the Somma ring of Pelée bounds the little plateau on the north, but there

translated in the 'Century Magazine'[1] from the issue of 'Les Colonies' for May 7, from the description by Lafcadio Hearn,[2] and from my own observations while on and near the mountain, the Étang Sec was the real crater lake of Mt. Pelée corresponding, though dry since the eruption of 1851, to the crater lakes of La Soufrière, on St. Vincent, Mt. Misery, on St. Kitts, and others. Its basin is said to have contained water until the eruption of 1851 drained it. The Étang Sec is stated to have been 700 meters (2300 feet) above the sea; its plain was estimated to be about 300 meters (986 feet) across, and the great circle surrounding it was judged to be about 800 meters (2628 feet) in diameter at top. This last estimate agrees closely with my estimate of the diameter of the present crater at top. The walls of the ancient crater must have risen almost precipitously from 1600 to 2100 feet above the Étang Sec, except on the southwest, where was located the great gorge through which flowed the waters of the Rivière Blanche, the sources of which were within the ancient crater.[3] Before the eruption which began last April, the crater of Pelée, except for the size of the great gash, must have been very much like the crater of St. Vincent's Soufrière and that of Mt. Misery, St. Kitts, as I saw it July 8 on my way home, and probably those of the other volcanic cones of the Lesser Antilles.

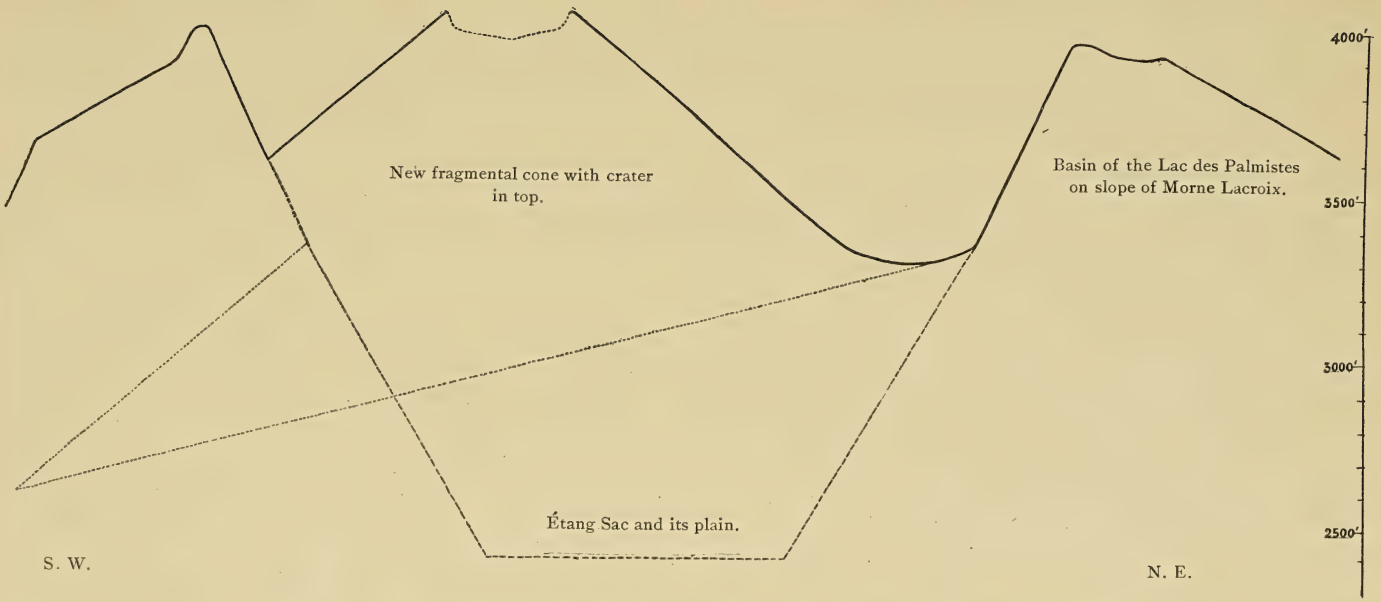
The whole interior of the crater was not seen by us entirely free from steam at any one time, but enough was observed for us to determine its character in its eastern, southern and western portions and to infer the shape of the remainder. The crater, like that of the Soufrière, is in the top of a broad,

is no cliff to the south, on the contrary the plateau slopes off to the south into the head ravines of the Falaise River. It seems as if Deckert must have gotten his north and south points interchanged in his description. The two small craters of 1851 mentioned by Deckert (*loc. cit.*, p. 426) are covered now, probably, by the inner cone, while the series of little craters in the gorge below those of 1851 must have become covered by the débris from the same cone, or have had the evidences of their existence destroyed by the tornadic blasts of the present eruption.

[1] Century Magazine, Vol. LXIV, p. 631. August, 1902.

[2] "Through a cloud-rift we can see another crater-lake twelve hundred feet below, said to be five times larger than the Étang we have just left [the Lac des Palmistes, near the summit]. It is also of more irregular outline. . . . It occupies a more ancient crater and is very rarely visited; the path leading to it is difficult and dangerous,—a natural ladder of roots and lianas over a series of precipices. 'Two Years in the French West Indies,' by Lafcadio Hearn. P. 288.

[3] See Romain, *loc. cit.*



Section across the Summit of Mt. Pelée from S. W. to N. E., July 6, 1902.

Horizontal and vertical scales the same. Heights hypothetical, except on northeast side. The shape of the crater in the inner cone is entirely inferential. The relation of the great southwestern gash to the fragmental cone is indicated by the dotted line. The broken lines complete the profile of the great ancient crater, as it existed before the eruption of May 8, 1902. The fragmental cone was the scene of greatest activity, but there seemed to be another considerable centre of eruption in the northeastern side of the crater at the base of Morne Lacroix.

truncated cone of ancient tuff agglomerate alternating with lava beds. Some diametral enlargement has taken place, perhaps, during this eruption, though not enough to change the sky-line of the top to any great degree, except in the southwest side. A careful study of the two photographs reproduced on Plate XLIII shows that the old gash there has been greatly widened, and perhaps deepened. The lower part of the outside of this old cone has an angle of slope of 20°, while the upper part is as steep as 30°, according to my determinations. Measurements of the inner slope gave values of 40° to 65° in the portion carved out of the old agglomerate, but the angles increased to 75°, 85°, and even showed great overhanging blocks on the eastern side where the old lava beds form the rim. In the western portion of the crater rises a cone of fragmental material, consisting of dust, ashes and large and small blocks and bombs. This cone is the scene of the greatest activity in the crater and it grew materially in size between the day when I first saw it, May 21, and July 6, when I got my last glimpse of it. It partly fills the old crater, and probably more than compensates for the material torn and undermined from the old walls and thrown out by the eruptive action of the volcano. A large proportion of the activity of the volcano, aside from that of the great outbursts, has gone into the building of this cone (see profile, Plate XXXVI).

The illustration, Plate XLIV, Figure 2, gives the sight I obtained of the inner cone from the eastern side of the crater. At that time its top must have been just about on a level with or, perhaps, somewhat higher than the camera, which was 3950 feet above tide, by aneroid reading. The photograph shows that there was a depressed crater in the top of the inner cone. My measurements of the angle of slope of the southern side of this cone determined it to be 38° to 40°, but there were precipitous portions. The material which rolls and slides down the southwest side of this cone continues directly into the gorge of the Rivière Blanche. The steep-sided valley formed by the inner cone and the inner slopes of the crater rim forms a continuation of the gorge of the Blanche and rises at a considerable angle from the southwestern gash to the base

of the rocky precipice on the eastern side of the crater, where it may be 800 feet in depth. The valley probably continues around the northern side of the inner cone rising in a spiral, for it appears at an elevation of at least 3600 feet on the western side, between the rim of the crater and the cone on the northwest side of the great gash. The new fragmental cone rises, apparently, on the site of the new crater mentioned by Romain, a conclusion which seems to be in agreement with the account of the eruption of May 8 by M. Fernand Clerc as given by Kennan,[1] which is as follows: "About eight o'clock, with a rending, roaring sound, a great cloud of black smoke appeared suddenly on the southwestern face of the volcano near its summit, and rushed swiftly down in the direction of St. Pierre, . . ." Before this outburst, M. Clerc had been observing the great column of vapor rising from the other principal center of eruption, which is located in the valley within the great crater at the base of the high point of rock on the eastern edge (the remains of Morne Lacroix). At intervals columns of steam rise energetically from other parts of the crater valley.

The history of the present series of eruptions may be epitomized somewhat as follows: the gradually returning activity of the volcano began to make itself very manifest in the latter part of April, since visitors to the crater found warm water in the basin of the Étang Sec on the 25th of that month, and the lake was deep. Columns of dust-laden steam rose from an opening within the old crater on the east side of the Étang Sec and from one on the west side of the same basin, and cones rose about these openings. Water in large quantity collected in the old lake basin, assisted, perhaps, by a dam formed across the gorge by the ejecta from the western crater. The water was heated by the action of volcanic forces. On May 5 the heated waters of the crater broke through this dam and rushed, as a deluge of mud and boulders of all sizes, down the gorge of the Rivière Blanche, and overwhelmed the Guérin sugar factory, which was situated at the mouth of the stream. On May 8 began the series of great explosions which have

[1] The Outlook, Vol. LXXI, p. 683. July 12, 1902.

sent steam laden with sulphurous gases, dust, ashes, and stones again and again over the southwest slope of the mountain with the violence of a tornado, several times reaching to St. Pierre and beyond. The author would explain the blasts in the same way as in the case of St. Vincent (see p. 341), but the great gash in the side of the crater of Pelée and the position of the neighboring ridges concentrated the force of the explosions in a certain direction and along a comparatively narrow zone — and the city of St. Pierre with its 26,000 inhabitants[1] and thousands of refugees lay in an amphitheatre, a regular *cul-de-sac*, directly in the path of the blasts. The new cone has risen above the western of the two openings just mentioned, and probably now entirely covers the site of the Étang Sec (see profile, Pl. XXXVI).

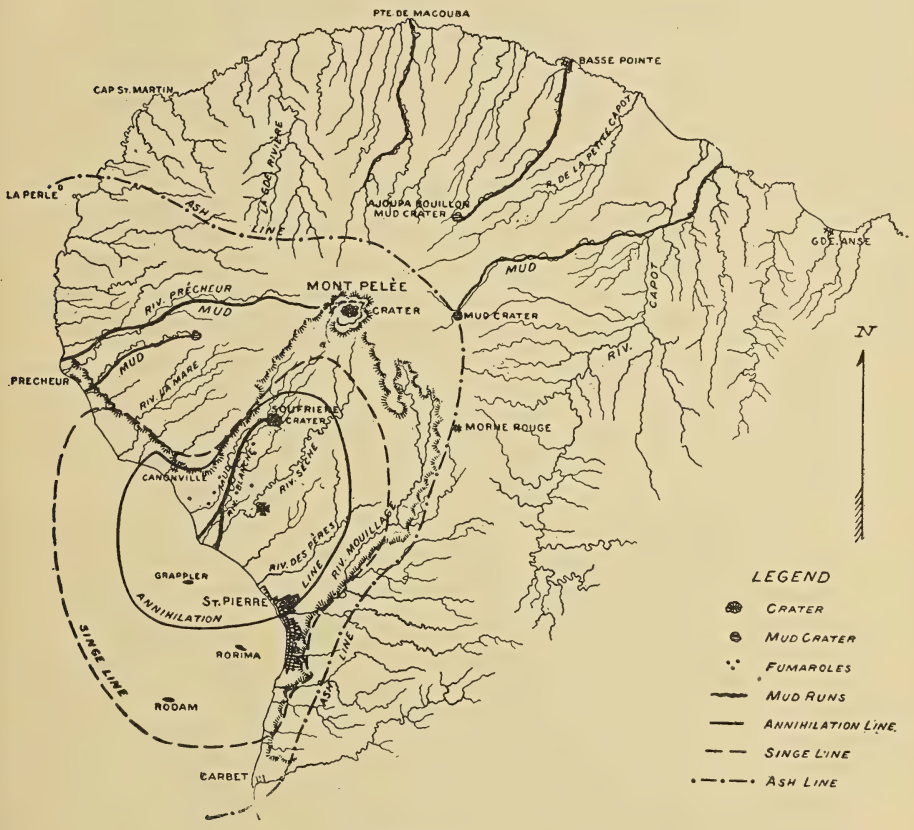
There seems to be no crater or center of eruption in the gorge of the Blanche below the great crater, or in the gorge of the Sèche,[2] but there has been much secondary action along the lower portion of their courses, and much steam, with or without large quantities of dust, has been thrown high into the air when water has reached the heated interior of the vast beds of volcanic ash deposited there during this eruption. Mud-flows and torrents have been very numerous down the

[1] Population in 1895, 25,382, according to the 'Century Atlas.'

[2] Prof. Angelo Heilprin has stated in his article in 'McClure's Magazine' for August 1902, and elsewhere, that eruptions have taken place from a crater located in the gorge of the Rivière Blanche some distance below the great crater. Mr. R. T. Hill has expressed the same idea in his extended article in the 'National Geographic Magazine' (Vol. XIII, pp. 251, 261) for July, 1902, and speaks of this as the center from which came the blast that destroyed St. Pierre. He has recorded the matter on a map which was published on p. 260 of the 'National Geographic Magazine' and which is reproduced here of the same size. Mr. Curtis was with Mr. Hill when the latter made the observations on which this map was based, and therefore knew the spot intended to be represented. He (Curtis) and I stood on the brink of the gorge of the Blanche overlooking it on June 24, examined it again with field glasses from the rim of the crater, where we obtained a view directly through the gorge lengthwise, and repeated the examination from the crater rim on June 26. We could see no crater or center of eruption in the gorge of the Blanche below the great crater, though there has been much secondary or superficial eruption of steam from the ash-beds along the gorge.

I cannot agree with the distribution of the 'zones of devastation' indicated on Hill's map or with the location of 'mud craters' as the origin of the mud-flows of the Sèche, the Blanche, the Falaise and other valleys. It is well to separate the devastation into zones of 'annihilation' and 'singeing,' in a general way, but the crater of the volcano should certainly be included within the former instead of being placed outside the latter, as is done on Hill's map. The real location of the singe line is nearly that of Hill's 'ash line' and is indicated approximately on my map (Plate XXXV), where it is called the limit of devastation. The 'ash line' should be placed at some undetermined distance far beyond the shores of the island of Martinique. The existence of real 'mud craters' on the slopes of Mt. Pelée seems very improbable, for the reasons given on pages 351 and 362 and elsewhere in this Report. The mud-torrents of the Grande Rivière, which were among the heaviest of those experienced on the north and northeast side of the island, are not indicated on Hill's map.

gorges of these streams and on the plateau between them. Some of these flows have come directly from the crater, especially in the case of the Blanche, others have originated on the exterior slopes of the old cone, while others have started in the heavy ash-beds in the gorges in the manner already described in connection with the Wallibou River, St. Vincent, and the Falaise River on the eastern side of Mt. Pelée.



SCALE, 1 INCH = $2\frac{1}{2}$ MILES.

MAP OF NORTHWESTERN PART OF MARTINIQUE BY R. T. HILL.

Reproduced in the exact size from the 'National Geographic Magazine' (Vol. XIII).

On the Sèche-Blanche plateau at an elevation of about 1000 feet above tide and just below the beginning at this point of the steep cone there is an area of one or two acres which probably has been the scene of more secondary action than any other area on the flanks of the mountain, on account of its favorable location for the reception of immense quantities of hot ashes and stones from the eruptions of the volcano. The secondary outbursts from this spot seem to have led some observers to the conclusion that a real crater was located here. I traversed this place twice on June 24 and twice on June 26 and found the ground hot, with many strong fumaroles sending out highly heated air and vapor, but I should not regard it as a crater. Mud-flows have originated above, below and within this area which have rushed down the plateau, as well as along the old watercourses to the sea. I saw several places where such streams of fluid mud had originated through the breaking of the dikes of temporary ponds, which probably were made by secondary outbursts of steam, though the formation of such a pond is not essential to the starting of a mud-flow. The surface of one of the mud-flows on the plateau is shown in Figure 1 of Plate XLVIII. Subsequent rain has washed the fine mud from the stones.

These streams of mud and stones present some characteristics which distinguish them clearly from the surfaces of undisturbed ash-beds. The most striking of these is the existence of curved folds or wrinkles transverse to the direction of flow of the stream, the folds varying in size with the size of the flow. The little streams which break through crevasses in the edges of the main stream, for on a flat surface, the mud flows in partly elevated channels, show wrinkles parallel to the main channel, when they first leave the parent stream. The surface of an unmodified deposit of ash presents a drifted appearance like that of a field of snow or of dry sand on a sea beach, and the Richmond estate as illustrated in Plate XLI is a typical example. The plateau between the Des Pères and Roxelane Rivers, on which was located the Fort Quarter of St. Pierre, was covered with several feet of wind-drifted ash, and it was not a mud-flow or a series of mud-flows which

destroyed this portion of the city, as has been stated in several publications.

In addition to the showers of dry dust and ashes, there fell during the eruptions an immense amount of liquid mud which had been formed within the eruption cloud through the condensation of its moisture. This mud formed a tenacious coating over everything with which it came in contact. That drops of mud too formed in the air and fell as a feature of the eruption is proven by the condition of the walls of the houses in Prêcheur, on which I found flattened spheroids of dried mud which could have formed only in the manner indicated. These flecks of mud were two, four and even six inches across, where two or more had coalesced. They occurred mostly on the northern and eastern walls of the houses. The testimony of the people as to the occurrence of rain during the great eruptions is conflicting, but the existence of this coating and these drops of mud proves that much aërial condensation of steam accompanied the outbursts. Furthermore, the normal rainfall in the mountains is much greater than it is on the lowlands.

During the latter part of our stay on the crater rim on June 24 the rain fell in torrents and the deluge continued until we reached the hot area described on page 360 on our return journey, the heaviest portion of the storm lasting for an hour or an hour and a half. Here we found the fumaroles sending out more steam than they did on our upward journey. When we crossed the Sèche River, we found a foot and a half of yellow, muddy water in place of the two or three inches which we had noticed there in the morning. We had not climbed out of the lowest gorge of the river, before our attention was attracted by the heavy eruption that was taking place from the crater and that was sending enormous clouds of dust-laden steam down the gorge of the Blanche to a point below the so-called Soufrière crater. Thunder-like noises nearer at hand had already made themselves heard and in another minute a wall of hot water ten or fifteen feet high swept with railroad speed over the place where we had crossed the river, and rushed on to the sea. The roar of the torrent was like that of a train,

and the water dashing from side to side of the narrow gorge caused the ground on which we were standing to tremble like a ship when her propeller 'races.' The water was thick and as black as ink with its load of volcanic ash, and it transported with ease boulders five feet in diameter which it had excavated from its banks. In many if not most instances these boulders were the ejecta of the present eruption. To the left a stream of thick, yellowish mud was flowing down from the plateau of the Sèche-Blanche which we had left a quarter of an hour before and was cascading into the Sèche directly beneath us. Soon the black torrent cut into the ash-beds along its banks sufficiently to reach their still highly heated interiors and cause columns of steam to shoot hundreds of feet into the air. The steam columns carried great clouds of black and light brown volcanic sand scores of feet upward. The hot area of the plateau also was sending skyward great columns of steam, and the whole formed a scene seldom witnessed, difficult to describe and never to be forgotten. The next day we measured the gorge and found that the Sèche had deepened its channel at least ten feet in the loosely compacted recent ash during the hour which the flood lasted.

In this instance it seems evident that there was close connection between the heavy rain, the eruption and the black torrent. Two explanations present themselves for consideration: (*a*) the crater may have thrown a mass of accumulated rainwater and ashes bodily over into the head cañon of the Sèche; (*b*) the rain which fell into the crater may have been the exciting cause of the eruption, but the mud-torrent may have been due to the soaking of the heavy coat of ashes on the steep outer slope of the old cone at the head of the Sèche until the resulting fluid mass slid off from the comparatively hard surface beneath and poured down the gorge of the river. There was plenty of water-soaked mud and ashes on the upper part of the mountain to supply the avalanche and some of it was on the verge of fluidity at the time of our visit, hence the latter explanation seems the more reasonable. The little tributary of the Sèche which empties into it on the southeast side close to our point of observation did not show any corre-

sponding torrent, because it does not head on the side of the great cone.

The mud-flows which have descended the Prêcheur River cañon have had ample collecting ground in the 'Atrio del caballo,' to use a Vesuvian term, on the north and northeast sides of the great crater, where the fine dust settles in vast quantities ready, when sufficient water has been added to it, to descend through a narrow gorge into the valley of the Prêcheur. When I was walking along the crater rim above the 'Atrio' June 20, my footsteps started small mud-flows down the outer cone, so liquid was the mud at that time. The ordinary action of the volcano is to deposit dust of impalpable fineness on the inner face of the crater rim. When this deposit becomes thick, it is ready to be swept off by a copious rain and carried through the great southwestern gash out of the crater and down the gorge of the Rivière Blanche as a mud-torrent or flow. There does not seem to the writer to be any need of locating 'mud craters' at the heads of or along the line of the gorges which have been the courses which these torrents of liquid mud have followed to the sea.

Where the tuff agglomerate of the old (outer) cone had been freed from its coat of ashes, especially in its lower portion, *i. e.*, from 1000 to 2000 feet above tide, it showed a smooth, somewhat fluted surface, the soft boulders having been planed off even with the matrix. The whole showed striations parallel with the slope, so that the surface looked like the glaciated rock surfaces so common in the northern latitudes. The planing and the striations seem to have been due to the scouring action of the ash avalanches in this part of their course. They ceased where the steep slope of the cone changed to the gentle slope of the plateau and thus gave opportunity for the material of the avalanches to check its descent and pile up. The sides of the radial gorges on the flanks of Mt. Pelée show approximately horizontal striations. Near the stream beds such striations occur on both sides of the gorges, and are due to abrasion by the sand and stones carried by the torrents. High above the stream on the bluffs facing the crater there are similar striations, but these must have been made by

sand-blast action during the hurricanes of dust-laden steam resulting from the explosions during the great eruptions. These striations extend to the very tops of bluffs rising 500 feet and more above the stream beds at their bases. Some of the sand-blast striations are illustrated in Figure 2 of Plate XLIX.

Erosion seems not yet to have cut deeply into the old land-surface since or as a feature of the eruptions, because here and there all over the mountain side one can find undisturbed roots and charred grass still in place. The shore line from Ste. Marthe Point nearly to Cap St. Martin has been somewhat altered since the eruptions began, some of the river deltas having been built out by the new material brought down by stream and torrent, while others have been cut back by the waves. The most important example of the cutting back is near the mouths of the Sèche and the Blanche, where local land-slides have assisted the sea in forming nearly vertical bluffs from ten to thirty feet in height. These bluffs show sections of the old and the new material now composing the plain. The little ash island which was formed near the mouth of the Rivière la Mare between May 8 and 23, and which was visited on May 23 by Mr. Curtis and two companions, had been washed away by June 14. The stone pavement laid on the beach of St. Pierre was cut into in places, perhaps by the return waves from the ocean accompanying the great outbursts.

The mud-flow which swept down the Grande Rivière reached the village of the same name at 4 A.M., May 8, four hours before the eruption occurred which destroyed St. Pierre. Three other great mud-flows have traversed this river: on May 11, June 6, and June 22, though no great eruption of Pelée took place on May 11 or June 22. The eruption of June 6 was one of the heaviest that occurred; this time the mud-torrent reached Grande Rivière village about an hour and a half before the eruption took place. The flood of May 8 was the most violent and was three meters (about 10 feet) deep where the valley of the river opens onto the sea coast, according to M. Delsol Désiré, the mayor's deputy of Grande Rivière.

He gave me the foregoing particulars in regard to these floods. The fine mud of these flows entered the buildings on the banks of the river as if it had been thick syrup. In one room that we examined the line of highest level was even with the top of an ordinary table, which would show that the mud was 30 inches deep in the room. At the time of our visit the deposit was nearly dry and it showed a shrinkage of but eight inches or 27 per cent. In another room the shrinkage was greater, showing that the mud there was thinner when it flowed in. Streams composed of such material as this would have great power in the transportation of boulders. The sizes of the boulders brought down by the mud torrents and deposited on the flood plain of the stream above the village and in its old channel may be inferred from Figure 2, Plate L. Some of those measured were eight feet across. The boulders seem to be from old deposits, since they have weathered surfaces. They show fresh abrasion along edges and at corners, due to their recent trip down the gorge. The mud is made up of gray material from the present eruption, together with a large proportion of yellow sand from the old beds through which the river runs. The vast amount of material brought down by the torrents has extended the delta plain fully five hundred feet into the sea and has pushed out the shoreline for several hundred yards on either side of the mouth of the river.

At Basse Pointe the history in regard to floods or torrents of mud has been similar. The principal disasters occurred on May 8 and 27, but the latter was the greater and most of the destruction was wrought on that occasion. Here too the deltal plain has encroached five hundred or six hundred feet on the sea and the ocean currents have spread the surplus material as a new beach for a long distance north and south of the mouth of the river, destroying the little artificial harbor of the town. Boulders ten feet across were brought down and left in the town by the floods, and deposits of sand, gravel, and boulders fifteen to eighteen feet deep rest upon the site of the old market place, which was at the mouth of the river. The thick mantle of mud which coated the great boulders when the first foreign visitors reached Basse Pointe after the floods, had

been washed off by the rains before we reached the place on July 5. The changes made in the shoreline may be learned in part from the photograph reproduced as Figure 1 of Plate L, the houses in the foreground being upon the old shoreline.

The ruins of the city of St. Pierre presented a very interesting field of study, but mostly in the line of speculations as to the cause or causes of the terrible destruction of human life. The walls of the houses (see Pl. XLV, Fig. 1) showed that one or more blasts of tornadic violence had swept over the city and that they came from the direction of the crater of Pelée, for the east and west walls — transverse to the direction of the crater from the city — were thrown down and demolished more generally than the north and south walls. Photographs taken between May 8 and 20 indicate that the first great eruption did less damage to buildings than was wrought by the second. The direction in which most of the trees were felled indicates the same thing, but the trees in the angle of Morne Mirail, which rises behind the middle of the city, were thrown over at all angles progressively, showing that a vortex was formed there. As is indicated by the gradually decreasing degree of destruction in passing from the northern to the southern part of the city (compare Pl. XLVI, Fig. 1, and Pl. XLVII with Pl. XLV), the blast diminished in force as it progressed and expanded, but when it reached Ste. Marthe Point it still had strength enough to throw the statue of Notre Dame de la Garde from its pedestal. The statue, which is of hollow iron ten or eleven feet high, now lies on the edge of the bluff with its foot about fifty feet S. 10° W. from its original position on the pedestal, and directly in line with the crater (see Pl. XLVI, fig. 2). The guns in the Ste. Marthe and Morne d'Orange batteries were thrown from their carriages in the same direction. More than once when I was on the rim of the crater or on the west flanks of the mountain I saw great clouds of dust-laden steam come out of the gash in the side of the crater with sufficient force to descend the gorge of the Rivière Blanche with great rapidity a full mile (*i. e.*, to Hill's 'Soufrière crater') before rising in columns. It was not difficult to imagine that, if this happened when the crater was sending a steam and dust

column only one or two thousand feet high, the action would be vastly greater and even like a hurricane in violence, when the crater was in full eruption and was sending its ash-laden steam column from five to seven miles, or more, into the air.[1] Captain Fraser of the steamer 'Madiana' told me that the hurricane of 1891 left Mt. Pelée as barren of vegetation as it is today. That blast of course carried no great load of volcanic ash like that which burdened this volcanic hurricane to assist it in the work of stripping the hillsides of their verdure.

It does not seem necessary to call in any forces new or strange to the history of vulcanism to account for the phenomena attending the eruption of Mt. Pelée, or the destruction of St. Pierre and its people. The 'flames' reported were perhaps the incandescent stones and bombs flying through the air; and these certainly would set fire to any combustible material upon which they fell. The officers of the French cable-repair ship 'Pouyer Quertier' were eye-witnesses of the eruption of May 8 and describe the cloud as being black when it issued from the crater, but say that it became luminous as it approached the coast.[2] Several times at night during our stay we saw the inner cone of the crater outlined and streaked with lines of 'fire' due to rolling and sliding red-hot rocks and lapilli, and this light was reflected from the steam clouds above the cone. The existence of notable quantities of burning or inflammable gases in the discharges from the volcano seems to me to be as yet undemonstrated.

On two occasions, June 24 and 26, I went into the crater for a short distance beside the southwestern gash and several times was surrounded with heavy clouds of steam from within the abyss. The steam, which was warm, but not hot, when it reached me, contained much sulphur dioxide, SO_2, and at times some hydrogen sulphide, H_2S, but I could not detect the odor of any other gas. The sulphur gases made the atmosphere

[1] Lieut. B. B. McCormick, U. S. N., in command of the 'Potomac,' was on his vessel in the harbor of Fort de France May 20 and made measurements of the angular distance to which the steam column rose during the great outburst that morning. The column subtended an angle of about 30° and the tug was 13.5 nautical miles in a straight line from the mountain. The height of that column therefore was approximately nine miles above the sea, no allowance being made for foreshortening.

[2] Heilprin, *loc. cit.*, p. 367.

difficult to breathe, but the most uncomfortable sensation was due to the irritation caused by the fine, angular dust getting into the respiratory passages and the eyes. Such a mixture, raised to a high temperature, and containing a large amount of dust and a considerable percentage of sulphur gases, would be almost instantaneously fatal to life. It was a cloud like this that rolled over and enveloped St. Pierre for several minutes about eight o'clock on the morning of May 8, and must have caused most of the deaths.

Some of the other causes of death were, (1) blows from falling stones which had been hurled out from the volcano, (2) crushing beneath falling walls and various objects (one man was found with his back broken by a sign which had fallen from over a store front), (3) burns due to hot stones and dust, (4) burns caused by steam alone and (5) by steam mingled with dust, (6) cremation in burning buildings, (7) nervous shock, (8) suffocation from lack of respirable air and, perhaps, (9) lightning. No autopsy was made on any of the thousands of victims of the disaster on Martinique, although men capable of performing such operations had the opportunity of making them within a very few hours after the eruption, hence there is no sure way of determining whether poisonous gases other than those mentioned played any part in the destruction of life. Immanuel Lédée, one of the survivors of the crew of the 'Roraima' told me that when the mucous membrane of his mouth, throat, and nose sloughed off on account of the burning, it was found to be full of the fine black (gray) dust. He was taken to the hospital at Fort de France after the eruption. Samson Cil-Barice,[1] the prisoner who is the sole survivor of the persons within St. Pierre at the time of the eruption, told me in Morne Rouge on June 18 that it was the hot dry 'sand' which sifted in through the window of his cell that caused his terrible burns.

The term 'stellar lightning' has been proposed by George Kennan for the particular form of electrical discharge characterizing the eruptions of Mt. Pelée. This expression, how-

[1] This name is spelled very differently in the various accounts of the disaster. The spelling here is that given me by my interpreter in the presence of the man himself.

ever, implies that the bolts shot out radially from a center in all directions at the same instant, whereas the shafts flew out successively in the different directions. Often they seemed to come from centers, but this appearance probably was due to the foreshortening of the line along which the successive flashes originated. The amount of electricity generated by the friction of the ascending column and the moving clouds of dust-laden steam against the surrounding atmosphere was very great, but much of the discharge seemed to be comparatively noiseless. At midnight of June 26 an eruption occurred which sent up a steam column to a height estimated at 12,000 feet above the top of the mountain. Much of this scintillating[1] lightning played about the column and the 'mushroom' cloud above, but no sound of thunder could be heard from our sloop, which was at anchor off Carbet, seven miles distant. The same form of electrical discharge was observed in connection with the great outbursts of La Soufrière on St. Vincent.

Appendix.

As the pages of this 'Preliminary Report' are passing through the press the newspapers report renewed violent activity in both St. Vincent and Martinique. These reports state that Mt. Pelée has been in constant eruption since August 15 with especially severe outbursts during the nights of August 25, 28 and 30 and September 3, and that La Soufrière broke out again September 1 and on September 3 suffered an eruption greater in force than those of May 7 and 18. No additional loss of life is reported from St. Vincent, but from Martinique comes the news that about 1500 victims must be added to the list of those destroyed by Mt. Pelée.

The dispatches indicate that the devastation on St. Vincent by this last eruption extended southwest considerably beyond the limits of the devastation of May 7 and 18, and that the area seriously affected then and indicated on the map

[1] 'Coruscating' is the excellent descriptive term applied by Dr. Jaggar.

accompanying this Report (Pl. XXXIV) has received a fresh coat of lapilli even greater than that received in May.

Under date of September 5, Wm. J. Durrant, druggist, of Kingstown, St. Vincent, writes me that great volumes of 'smoke' and steam began rising from La Soufrière at 1 P.M. of September 3, but that the violent outburst did not begin until 9:30 that night. Three hours later the eruption was at its height and the last explosion occurred at 5:40 A.M. The roaring of the volcano from midnight onward was continuous and was terrifying even at Kingstown, while the electric display about the great column of dust-laden steam surpassed those of May 7 and 18. The matter ejected by this last eruption is described by Mr. Durrant as being 'a heavy, black sand[1] of the coarseness of blasting powder, with plenty of pumice, but very few stones.' Very little light gray ash like that of the May eruptions fell this time. Richmond

[1] A sample of the material thrown out by the eruption of the Soufrière September 3 was received from Mr. Durrant September 25 and has been examined while these last pages are on the press. It consists of fine and coarse volcanic sand and gravel, apparently for the most part comminuted ancient lavas of the volcano. The fragments from 3 to 15 millimetres across show the coarsely crystalline structure of the old lavas and many of them show that they are parts of weathered masses. Olivine, pyrite (pyrrhotite?) and porphyric crystals of feldspar, hypersthene and hornblende are abundant in these fragments and the separated minerals make up a large proportion of the particles about 2 millimetres in diameter. A comparatively large fragment (20 mm. in diameter) shows phenocrysts of feldspar imbedded in dark brown and light brown scoriaceous glass which is apparently fresh. All the fragments and the particles of sand are coated with dust which seems to be as fine as any that fell during the May eruptions, so that the explanation of Mr. Durrant's statement regarding the relative absence of fine dust from the ejecta of September 3–4 may be that the wind carried most of such material northward and westward away from Kingstown, his point of observation. The cloud from this eruption of La Soufrière is reported to have produced darkness for about six hours on September 4 in Fort de France, Martinique.

The dust-coated sand is dark gray when dry, but is almost black when wet, justifying the description quoted from Mr. Durrant's letter. Comparison of this new material, however, with that collected by myself, May 23–June 10, indicates that there is no essential difference between the ejecta of the earlier and the later eruptions.

The following chemical analysis, which was not received in time for insertion in its proper place in this Report, is of dust from the May eruptions which I collected May 27 in a room in the Langley Park estate house, about one mile north of Georgetown, St. Vincent, in which 21 dead bodies were found after the eruption of May 7. The analysis was made by Dr. W. F. Hillebrand of the United States Geological Survey, to whom our acknowledgments are due, and is the unpublished analysis referred to in his article in the 'National Geographic Magazine' for July (Vol. XIII, p. 297) as emphasizing the greater amount of sulphur present in the ejecta of La Soufrière than in those of Mt. Pelèe. The absence of chlorine is interesting as indicating fresh waters as the source of the steam of the eruptions.

SiO_2	55.08	
Al_2O_3	18.00	
Fe_2O_3	2.46	(Only approximate, because of effect of pyrrhotite, 0.91 %—see below.)
FeO	4.57	
MgO	3.34	
CaO	7.74	
Na_2O	3.45	
K_2O	0.65	
H_2O at 100° C.	0.66	
H_2O above 100° C.	1.39	
TiO_2	0.80	

Vale[1] estate received about 8 inches of ash, Chateaubelair about 6 inches, Petit Bordel[2] about 4 inches. Southward the coat of ash diminished to Peter's Hope, an estate on the west coast about ten miles southwest of the crater, where it ceased to be of importance. The beginning of this eruption was a mud-flow toward the site of Morne Ronde village.

Regarding Martinique, the telegrams state that the village of Morne Rouge has been destroyed and that the area of devastation has been extended five miles on the eastern side of Mt. Pelée. If the latter statement be true, nearly the whole northwestern section of the island, as shown in Plate XXXV must have been laid waste by the volcano, and the eruption of Pelée has risen already to the magnitude of that of the Soufrière. Morne Lacroix is reported to have disappeared altogether and the crater to have extended greatly toward the east. This may indicate that the vent under the new inner cone described in these pages has become partly clogged, and that the main activity has shifted to the vent mentioned (see p. 357) as being east of the Étang Sec at the base of the western face of Morne Lacroix. If this has taken place, as seems highly probable from the reported destruction of Morne Lacroix, the new inner cone acted as a dam in the great southwestern gash which played such an important part in the destruction of St. Pierre, so that the last eruptions came from a centrally located vent (like that of La Soufrière, St. Vincent) and the débris from the crater was distributed more symmetrically about the cone. The position of the great gash and neighboring cliffs with reference

ZrO_2	?
CO_2	None
P_2O_5	0.17
SO_3	0.24
Cl	None, or faint trace
S	(0.36) included in pyrrhotite below
NiO	None
MnO	0.21
BaO	Trace
SrO	None
Li_2O	Faint trace
Fe_7S_8 (?)	0.91
	99.67

[1] This is the estate mentioned in the footnote to page 334 as having been just outside the area devastated by the eruptions of May 7 and 18.

[2] The Petit Bordel estate is the one which I used as headquarters during part of my stay on St. Vincent.

to the vent on the western side of the Étang Sec, which was the most active center of eruption in May, June, and July, directed the blasts of the earlier eruptions toward St. Pierre and away from Morne Rouge. That directive factor having ceased to have force, through the growth of the inner cone and the (apparent) shifting of the center of activity to the eastern vent, Morne Rouge, a mile and a half nearer the crater than the middle of St. Pierre, came far within the area of destruction and received the full fury of an eruption.

The electrical phenomena attending these later eruptions of Mt. Pelée, also, are described as having been even more magnificent and terrifying than those observed in connection with the earlier explosions.

The sympathy in action between La Soufrière and Mt. Pelée, which was indicated in the eruptions of May, and the phenomena leading thereto, has been made more manifest by these later outbursts.

September 15, 1902.

FIG. 1.

EXPLANATION OF PLATE XXXVII.

Fig. 1.—La Soufrière, St. Vincent. Southwestern portion of the rim of the crater. The footprints on the crest are those of our party. See page 336.

Fig. 2.—La Soufrière. Southeastern portion of interior of crater. Column of steam rises from lake in bottom. View illustrates alternation of the beds of lava with those of tuff in the make-up of the island See page 336.

EXPLANATION OF PLATE XXXVII.

Fig. 1.—La Soufrière, St. Vincent. Southwestern portion of the rim of the crater. The footprints on the crest are those of our party. See page 336.

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Fig. 1.

Fig. 2.

EXPLANATION OF PLATE XXXVIII.

La Soufrière, southwestern side. Ruins of the *Wallibou* sugar factory, the effect of the eruption. The cliff in the foreground is the indication of the landslide which carried the site of the village of *Wallibou* into the ocean. These ruins are shown almost in the middle of Plate XXXIV.

EXPLANATION OF PLATE XXXVIII.

La Soufrière, southwestern side. Ruins of the Wallibou sugar factory, the effect of the eruption. The cliff in the foreground is the indication of the landslide which carried the site of the village of Wallibou into the ocean. These ruins are shown almost in the middle of Plate XXXIV.

Photograph by J. C. Wilson.

Ruins of the Wallibou Sugar Factory, St. Vincent.

EXPLANATION OF PLATE XXXIX.

Fig. 1.—La Soufrière, southeastern side. The Rabaka Dry River valley where it issues from the hills, showing bed of ashes where a gorge 200 feet deep existed before the eruption. From a distance looks like a glacier. See page 343.

Fig. 2.—La Soufrière, southeastern side. Trail to summit showing effects of volcanic blast. There was a bridle path on this ridge before the eruption. See page 341.

FIG. 2.

EXPLANATION OF PLATE XXXIX.

Fig. 1.—La Soufrière, southeastern side. The Rabaka Dry River valley where it issues from the hills, showing bed of ashes where a gorge 200 feet deep existed before the eruption. From a distance looks like a glacier. See page 343.

Fig. 2.—La Soufrière, southeastern side. Trail to summit showing effects of volcanic blast. There was a bridle path on this ridge before the eruption. See page 341.

Fig. 1.

Fig. 2.

EXPLANATION OF PLATE XL.

FIG. 1.

Fig. 1.—La Soufrière, southwestern side. Valley of the Wallibou River, showing ash-beds 50 to 75 feet thick, and a secondary or superficial outburst of steam. See page 343.

Fig. 2.—La Soufrière, southwestern side. Another secondary outburst of steam in the Wallibou valley. This superficial eruption threw a temporary dam across the river and caused a mud-flow. See page 343.

EXPLANATION OF PLATE XL.

Fig. 1.—La Soufrière, southwestern side. Valley of the Wallibou River, showing ash-beds 50 to 75 feet thick, and a secondary or superficial outburst of steam. See page 343.

Fig. 2.—La Soufrière, southwestern side. Another secondary outburst of steam in the Wallibou valley. This superficial eruption threw a temporary dam across the river and caused a mud-flow. See page 343.

Fig. 1.

Fig. 2.

THE RICHMOND ESTATE, ST. VINCENT.

EXPLANATION OF PLATE XLI.

La Soufrière, southwestern side. The Richmond estate, showing the wind-drift surface of the newly-fallen volcanic ashes. The deposit here was from 2 to 3 feet in depth. The building was wrecked in the hurricane of 1898, and had been only partly restored before the eruption which put it into its present condition. Chateaubelair Island is in the background at the right. See page 343.

EXPLANATION OF PLATE XLI.

La Soufrière, southwestern side. The Richmond estate, showing the wind-drift surface of the newly-fallen volcanic ashes. The deposit here was from 2 to 4 feet in depth. The building was wrecked in the hurricane of 1898, and had been only partly restored before the eruption which put it into its present condition. Chateaubelair Island is in the background at the right. See page 343.

Photograph by J. C. Wilson.

The Richmond Estate, St. Vincent.

EXPLANATION OF PLATE XLII.

FIG. 1.

Fig. 1.—La Soutrière. Valley of Wallibon River in the foreground. Dendritic drainage well illustrated on the divide between Wallibon and Tresbé valleys. See page 344.

Fig. 2.—La Soutrière. Trail to summit at 1500 feet elevation showing mud-covered ridge with almost unaffected coating on the crest.

EXPLANATION OF PLATE XLII.

Fig. 1.—La Soufrière. Valley of Wallibou River in the foreground. Dendritic drainage well illustrated on the divide between Wallibou and Trespé valleys. See page 344.

Fig. 2.—La Soufrière. Trail to summit at 1500 feet elevation showing mud-covered ridge with almost unaffected coating on the crest.

Fig. 1.

Fig. 2.

EXPLANATION OF PLATE XLIII.

Fig. 1.—Mt. Pelée, Martinique, from the west, before the eruption. Photograph by D. L. Elmendorf. See page 356.

Fig. 2.—Mt. Pelée from the west, showing the great crater. This photograph happens to have been taken from almost exactly the same position as the preceding, and a careful comparison of the two shows the changes wrought in the western side of the summit by the eruption. See page 356.

EXPLANATION OF PLATE XLIII.

Fig. 1.—Mt. Pelée, Martinique, from the west, before the eruption. Photograph by D. L. Elmendorf. See page 356.

Fig. 2.—Mt. Pelée from the west, showing the great crater. This photograph happens to have been taken from almost exactly the same position as the preceding, and a careful comparison of the two shows the changes wrought in the western side of the summit by the eruption. See page 356.

Fig. 1.

Fig. 2.

FIG. 1.

EXPLANATION OF PLATE XLIV.

Fig. 1.—Mt. Pelée. Southern rim of crater at about 3750 feet altitude.

Fig. 2.—Mt. Pelée. The inner cone of the crater, showing the scene of greatest activity. The crater rim in the foreground is 3050 feet above the sea. See page 350.

FIG. 2.

EXPLANATION OF PLATE XLIV.

Fig. 1.—Mt. Pelée. Southern rim of crater at about 3750 feet altitude.

Fig. 2.—Mt. Pelée. The inner cone of the crater, showing the scene of greatest activity. The crater rim in the foreground is 3950 feet above the sea. See page 356.

Fig. 1.

Fig. 2.

EXPLANATION OF PLATE XLV.

Fig. 1.—The ruins of St. Pierre from the south. The north and south walls have been injured by the eruption less than the east and west walls. Photograph taken June 14, 1902. Most of the destruction seems to have been wrought by the eruption of May 20. See page 365.

Fig. 2.—St. Pierre and portion of Rue Victor Hugo, May 21, 1902. It seems probable that many of the boulders in the foreground of the picture were thrown out from the volcano during this eruption. The heap in the middle of the picture, however, is composed mostly of rubble from the adjoining walls. See page 350.

EXPLANATION OF PLATE XLV.

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Fig. 1.

Fig. 2.

EXPLANATION OF PLATE XLVI.

Fig. 1.—St. Pierre. Valley of the Roxelane or Rivière des Blanchissenusses in the northern part of the city, as it appeared May 22, 1902. See page 366.

Fig. 2.—St. Pierre. Statue of Notre Dame de la Garde, which was thrown from its pedestal by the volcanic blast. The statue is of iron, hollow, about 11 feet high, and lies on the brink of the bluff, with its base about 50 feet from its original position on the pedestal. See page 366.

EXPLANATION OF PLATE XLVI.

Fig. 1.—St. Pierre. Valley of the Roxelane or Rivière des Blanchisseusses in the northern part of the city, as it appeared May 22, 1902. See page 366.

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Fig. 1.

Fig. 2.

EXPLANATION OF PLATE XLVII.

Fig. 1.—St. Pierre. Ruins of the great distillery in the Port Quarter of the city, showing the holes in the iron tanks, due to the volcanic bombardment. See page 340.

Fig. 2.—St. Pierre. Near view of one of the holes. The material of the tanks is quarter-inch boiler iron. See page 340

EXPLANATION OF PLATE XLVII.

Fig. 1.—St. Pierre. Ruins of the great distillery in the Fort Quarter of the city, showing the holes in the iron tanks, due to the volcanic bombardment. See page 349.

Fig. 2.—St. Pierre. Near view of one of the holes. The material of the tanks is quarter-inch boiler iron. See page 349.

Fig. 1.

Fig. 2.

EXPLANATION OF PLATE XLVIII.

Fig. 1.—Mt. Pelée, southwestern side. Mud streams of the Sèche-Blanche plateau at about 800 feet above the sea. See page 360.

Fig. 2.—Mt. Pelée, southwestern side. Ejected block on Sèche-Blanche plateau near sea coast. Block is about 30 feet long, 24 feet wide and 22 feet high. See page 348.

EXPLANATION OF PLATE XLVIII.

Fig. 1.—Mt. Pelée, southwestern side. Mud streams of the Sèche-Blanche plateau at about 800 feet above the sea. See page 360.

Fig. 2.—Mt. Pelée, southwestern side. Ejected block on Sèche-Blanche plateau near sea coast. Block is about 30 feet long, 24 feet wide and 22 feet high. See page 348.

Fig. 1.

Fig. 2.

EXPLANATION OF PLATE XLIX.

Fig. 1.—Mt. Pelée, southwestern side. The gorge on the Rivière Sèche through the ash-beds near its mouth.

Fig. 2.—Mt. Pelée, southwestern slope. The bluff in the center of the view shows the horizontal striation due to the action of the volcanic sand-blast. See page 364.

EXPLANATION OF PLATE XLIX.

Fig. 1.—Mt. Pelée, southwestern side. The gorge on the Rivière Sèche through the ash-beds near its mouth.

Fig. 2.—Mt. Pelée, southwestern slope. The bluff in the center of the view shows the horizontal striation due to the action of the volcanic sand-blast. See page 364.

Fig. 1.

Fig. 2.

EXPLANATION OF PLATE L.

Fig. 1.—Basse Pointe. View showing the extension of the delta and shore line by the great floods of May 8 and 27. The houses in the foreground stand nearly on the old shore line. See page 365.

Fig. 2.—Grande Rivière. Some of the great boulders left on the flood plain and in the channel of the river, above the village, by the torrents of May 8 and 11 and June 6 and 22. See page 365.

EXPLANATION OF PLATE L.

Fig. 1.—Basse Pointe. View showing the extension of the delta and shore line by the great floods of May 8 and 27. The houses in the foreground stand nearly on the old shore line. See page 365.

Fig. 2.—Grande Rivière. Some of the great boulders left on the flood plain and in the channel of the river, above the village, by the torrents of May 8 and 11 and June 6 and 22. See page 365.

Fig. 1.

Fig. 2.

Height of specimen 2 feet 2 inches.

EXPLANATION OF PLATE LI.

Volcanic bomb from Mt. Pelée. The peculiar 'bread-crust' surface of this mass shows that it was thrown out of the volcano in a half-melted condition and was cooled in the air. Collected by the American Museum expedition near the site of the Guérin factory. See page 347

EXPLANATION OF PLATE LI.

Volcanic bomb from Mt. Pelée. The peculiar 'bread-crust' surface of this mass shows that it was thrown out of the volcano in a half-melted condition and was cooled in the air. Collected by the American Museum expedition near the site of the Guérin factory. See page 347.

'Bread-Crust' Volcanic Bomb, Mt. Pelée.

Height of specimen 2 feet 2 inches.

Article XXVII. — MAMMAL NAMES PROPOSED BY OKEN IN HIS 'LEHRBUCH DER ZOOLOGIE.'

By J. A. Allen.

The second part of Oken's 'Lehrbuch der Zoologie,' published in 1816,[1] includes the Vertebrates, pp. 651–1284 being devoted to mammals. While Oken's 'Lehrbuch' has been rarely cited, account has been taken of some of the names first proposed in it, and when found to have priority they have been adopted; a few others quite as well entitled to recognition appear to have been overlooked. Such of the latter as relate to mammals are here considered.

Oken was almost as erratic and irregular in nomenclatorial matters as was Zimmermann in his 'Specimen Zoologiæ Geographicæ,' published in 1777,[2] but in some respects is less satisfactory, since he failed to cite authorities for the names used, and gave no references to his sources of information. Both diagnosed generic, subgeneric and other groups, as well as species, under either vernacular or systematic names, as seemed to please their fancy, and employed the names given by previous authors as these authors used them, regardless of whether the generic portion of the name conformed or not to the genus to which they assigned the species. Yet they each had a 'system,' — sadly defective, however, when tried by the nomenclatorial usages of to-day. But it is usually not difficult to determine what they meant to indicate.

In the case of Oken, many of the names which he gave were merely substitutes for earlier names. In the case of groups or species not previously named, upon which he bestowed names (fortunately few), their basis is clearly evident. He gave new names to all his higher groups, from classes down to his

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[1] [Lorenz] Okens | Lehrbuch | der | Zoologie. | — | Mit vierzig Kupfertafeln. | — | Zweite Abtheilung | Fleischthiere. | — | (Preis: 2 Thaler.) | — | Jena, bei August Schmid und Comp. | 1816.

Or:

Okens | Lehrbuch | der | Naturgeschichte. | — | Dritter Theil | Zoologie. | Mit vierzig Kupfertafeln. | — | Zweite Abtheilung | Fleischthiere. | . . . [Rest of title page as above.] — 8 vo., 3 ll.(=2 title pages and dedication), and pp. i–xvi., + 1–1270, 1 l. and chart of classification.

[2] See *antea*, pp. 13–22.

'Gattungen,' and to a large number of these, but as they are all vernacular and not technical they do not require consideration as an element in nomenclature. His 'Gattungen' are for the most part supergeneric groups, and in many cases conform to modern families rather than to genera. But he subdivided his 'Gattungen' into groups, or sections, that correspond nearly with the modern idea of genera. For these he adopted the names already given to them by previous authors or, with few exceptions, supplied new ones of his own, but left some under merely vernacular names or without names. As an exposition of this phase of the subject I subjoin his classification of the order of Rodents, in the sequence employed in the 'Lehrbuch.' This is not, however, the order in which the groups are given in his 'Nahmen zu Okens Zoologie', II, pp. i–xi; (Mammals, pp. ix–xi, Rodents, pp. ix, x); neither are the names and groups always equivalent in the list of names and in the text.

The text was evidently put together carelessly, as in several instances species of the same group are widely separated (see *Arctomys*, pp. 837 and 856), and there is apparently here and there some duplication.

II. Ordnung. *Lurchsucke—Pfoter.*

1. Sippschaft. Froschpfoter—Näger.

1. Gattung. Hasen.

1. Savia, Cavia.
   a. Hydrochaerus.
   b. Coelogenys.
   c. Dasyprocta.
   d. Cavia.
2. Lepus.
   a. Lagomys.
   b. Lepus.

2. Gattung. Bilche.

1. Jaculus.
   a. Dipus.
   b. Pedetes.
2. Murzer.
   a. Viscaccia.
   b. Arctomys.
   c. Bathyergus.
   d. Georychus.
3. Krietsche.
   a. Citellus.
   b. Cricetus.
   c. Aspalax.
   d. Mus bursarius.
   e. Tamias.
4. Schwirrel.
   a. Sciurus.
   b. Pteromys.
   c. Glis.
5. Pile.
   a. Loncheres.
   b. Mus spinosus.
   c. Coendu.

3. Gattung. Traner.

1. Hystrix.
2. Biber.
   a. Castor.
   b. Hydromys.
   c. Guillino.
3. Ondatra.

4. Gattung. Mäuse.

1. Mus.
   a. Meriones.
   b. Mus.
      a. Kleine Mäuse.
      b. Ratten.
2. Zeiste. [=Hypudæus.]
   a. Zeiste; klein, etc.
   b. Mus gregarius.
   c. Glareolus.
   b. Lemminge.
   b. Stossmäuse. [=Myospalax.]

I. Generic Names.

The following generic names are open to comment, and are noticed in the order of their occurrence in the 'Lehrbuch,' only those being mentioned which are not synonyms of earlier names, or which preoccupy later names.

Oryx (p. 672). =*Monodon* Linn., but of even date with *Oryx* Blainville for a genus of Antelopes. As Blainville's name has long been in current use and was published very early in the year 1816, there is no reason to question its tenability. It probably has a slight priority over *Oryx* Oken.

Viscaccia (p. 835). By restriction *Viscaccia* Oken equals *Viscaccia* Schinz, 1825. The authority is simply carried back to Oken. (See further on this case Allen, Proc. Biol. Soc. Wash., XV, 1902, p. —).

Citellus (p. 842). Type *Mus citellus* Linn., 1766. =*Spermophile* F. Cuvier, same type. (" . . . . je donnerai au groupe dont le Souslik devient le type, le nom de *Spermophile*." F. Cuvier, Mém. du Mus. d'Hist. Nat., IX, 1822, p. 304). Or: *Spermophiles* F. Cuvier, in Dents des Mamm., 1825, p. 160, where he again says: "Ce genre est formé du souslic.'

Also = *Citillus* Lichtenstein, 1830, primarily, and also by restriction. Lichtenstein separated the "europäischen *Ziesel* (dem polnischen *Suslik*)" as the type of a group which he took out of Cuvier's genus *Spermophilus*, leaving the other species

to be distributed in either *Arctomys* or *Spermophilus*. As the name chosen for the new group is the Linnæan specific name of the suoslik (changed in spelling from *citellus* to *citillus*), this species should be construed as the type of the genus *Citillus*, although he included under it three other species there described as new, only one of which, *C. mugosaricus*, is strictly congeneric with *C. citellus*.

As Oken's *Citellus* was based primarily on the *Mus citellus* of Linnæus and Pallas (*Arctomys citillus* Schreb.), as indicated not only by the name but by the forms placed under it, it has the same type as *Spermophilus* F. Cuvier, over which it has six years' priority (even accepting the name in its original vernacular form). As *Spermophilus* originally included only the souslik, it is a strict synonym of *Citellus* Oken. The fact that other authors later referred to it other species, as Lesson in 1827 (Man. de Mamm., pp. 243–245), who appears to have been the first author who employed the Latin form of the name, this does not render the name of the originally monotypic *Spermophilus* available for any of the forms later referred to it.

In this connection it becomes of interest to see what provision has been made for the numerous species long currently associated with the name *Spermophilus*. The named sections of the group are the following, to which it may be necessary to add others for a few well-marked types apparently as yet unprovided for. Such deficiencies should only be supplied, however, on the basis of a careful revision of the entire group. The names that have been proposed in a generic or subgeneric sense, for the existing forms, in the order of date are:

1. *Citellus* Oken, 1816, type *Mus citellus* Linn. = *Spermophilus* F. Cuvier, 1822;=*Citillus* Lichtenstein, 1830.
2. *Anisonyx* Rafinesque, 1817, type *Arctomys columbianus* Ord, preoccupied by *Anisonyx* Latreille, 1809, for a genus of Coleoptera.
3. *Otospermophilus* Brandt, 1844, type *Arctomys grammurus* Say.
4. *Collobotis* Brandt, 1844, type, *Arctomys fulvus* Lichtenstein.
5. *Otocolobus* Brandt, 1844, an alternative name for *Collobotis*.
6. *Ictidomys* Allen, 1877, type, *Sciurus tridecemlineatus* Mitchell.
7. *Spermophilopsis* Blasius, 1884, type, *Citillus leptodactylus* Lichtenstein.

8. *Xerospermophilus* Merriam, 1892, type, *Spermophilus mohavensis* Merriam.
9. *Ammospermophilus* Merriam, 1892, type *Spermophilus leucurus* Merriam.
10. *Callospermophilus* Merriam, 1897, type, *Sciurus lateralis* Say.

Grison (p. 1000). Type and only species, *Viverra vittata* Schreber = *Galictis* Bell, 1826, same type. Synonyms: *Eirara* Lund, 1839 (in part); *Grisonia* Gray, 1843. The name *Grison* follows, instead of precedes, as is usually the order, the name of the species, but *Grisŏn* stands as a technical name on p. xi.

Tayra (p. 1001). Based, as the name indicates, primarily on the 'Tayra,' or *Mustela barbara* Linn., but includes also the Pekan (*Mustela canadensis* Oken =*M. pennanti* Erxl.) = *Eira* H. Smith, 1842. Synonym: *Galera* Gray, 1843.

Thos (p. 1037). Proposed for, and includes only, the Jackals, the first species being *Thos C*[*anis*] *ceylonensis* Oken (= *Canis aureus* Linn., part). Synonyms: *Lupulus* Blainville, 1830; *Sacalius* H. Smith, 1839, which has the same type; *Oxygŏus* Hodgson, 1841, same type; *Dieba* Gray, 1869, type, *Canis anthus* F. Cuvier.

The species referred by Oken to *Thos* are: (1) *Thos C. ceylonensis*; (2) *Th. C. mesomelas;* (3) *Thos C. barbarus* (= *Canis anthus* F. Cuvier, 1824); (4) *Thos vulgaris* (= *Canis aureus* Linn).

Vulpes (p. 1033); **Lupus** (p. 1039). These names are used in combination with specific names and correspond to superspecific divisions of his *Canis*, but are not employed in a manner that entitles them to recognition in nomenclature. Brisson and Oken are strictly comparable in their use of these names, which are not tenable from either of these authors.

Panthera (p. 1052); **Tigris** (p. 1054); **Leo** (p. 1070). Oken divides his genus *Felis* into four primary sections, to which he formally applies only vernacular names, as follows. 1. Luchse [*Lynx*]; 2. Pardel, Lunzen [*Panthera*]; 3. Tiger [*Tigris*]; 4. Lowen [*Leo*]; but under each, in enumerating the species, he employs with considerable consistency their Latin equivalents, namely (respectively), *Lynx*, *Panthera*, *Tigris*, and *Leo*. The

species indicated by Linnæus and Pallas by these names are obviously to be taken as the types of these groups.

Lynx =*Lynx* Kerr, 1792, and of such recent authors as have made use of the name.

Panthera includes all of the spotted cats, both large and small, which he subdivided into minor groups on the character of the markings, etc., he placing *Felis pardus* Linn. (=*F. panthera* Pallas) as "Art. 7. *P*[*anthera*] *vulgaris*." This should obviously be considered as the type of *Panthera*, of which Gray's *Leopardus*, as used by him in 1843 (List Mamm. Brit. Mus., 1843, pp. 40–44), is practically equivalent.

Tigris and *Leo* respectively antedate *Tigris* and *Leo* of Gray, 1867, but are more comprehensive groups.

II. Specific Names.

Oken also gave many new specific names, he purposely renaming many species already named, and giving names to many others he considered new. These names in some instances antedate others given later to the same species; in other cases Oken's names preoccupy names given later as new by other authors. In most cases his names are identifiable but fortunately in very few instances disturb current names. The following ten, relating to American species, are all that will be given special mention here. A few others appear to be available for Old World species.

Lepus chilensis (sub **Viscaccia**), p. 836. The first name available for the Argentine Viscacha, having one year's priority over *Dipus maximus* Desmarest (1817, ex Blainville, MS.), as already shown in another connection. (*Cf.* Proc. Biol. Soc. Wash., XV, 1902, p. —.)

Hystrix paraguayensis (sub **Coendu**), p. 870. Based on 'Le Couiy' of Azara, for which it is the earliest name, antedating by six years *Spiggurus spinosus* F. Cuvier, 1822. The species should therefore stand as *Coendou paraguayensis* (Oken).

Lynx brasiliensis (sub **Felis**), p. 1050. Not satisfactorily identifiable. Attributed to Paraguay. Not *Felis brasiliensis*

Schinz, 1821, and probably not *Felis brasiliensis* F. Cuvier, 1828.

P[anthera] paraguayensis (sub **Felis**), p. 1052. Includes (1) the 'Ocelot,' which he describes at length, and (2) the 'Chibi-guazu,' the latter after Azara. If the Ocelot can be excluded on the ground of its having been previously named, only Azara's 'Chibigouazou' would be left as the basis of Oken's *paraguayensis*, which antedates *Felis mitis* F. Cuvier (1820), *Felis wiedi* Schinz (1821 =*Felis macroura* Weid, 1826), and other names later applied to practically the same animal.

P[anthera] mexicana (sub **Felis**), p. 1054. In part, and so far as it has any substantial basis, this is the same as *Felis mexicana* Desmarest, 1816 (ex. Buffon, Hist. Nat., Suppl., III, 227, pl. xxxiv), and hence the two names are of even date. Also =*Felis novæ hispaniæ* Schinz, 1825. It is of course, as Buffon believed, the Serval.

Leo niger (sub **Felis**), p. 1070. The black phase of the 'Jagouarondi'=*Felis jaguarundi* Fischer, 1814.

L[eo] griseus (sub **Felis**), p. 1070. The 'Jagouarondi' of Azara; hence =*Felis jaguarundi* Fischer, 1814. Not *Leopardus griseus* Gray, 1842 =*Felis griseus* Gray, 1867.

L[eo] brunneus (sub **Felis**), p. 1070. The 'Pajero' or Pampas Cat =*Felis pajeros* Desmarest of same date. The last name having probably slight priority in date of publication, and also having obtained currency while the other has not, is to be preferred.

Did[elphys] paraguayensis, p. 1147. As already shown (*antea*, pp. 251, 267), this name is based on Azara's 'Micouré premier,' and hence supplants *D. azaræ* Temminck, 1825.

Did[elphys] mes-americana, p. 1152. As already shown (*antea*, p. 251) this is the earliest name for the large opossums of northern Mexico.

Article XXVIII. — DESCRIPTIONS OF SOME LARVÆ OF THE GENUS CATOCALA.

By William Beutenmüller.

Plate LII.

In advance of a contemplated monograph of the species of *Catocala* found in America, north of Mexico, the following descriptions of larvæ of the genus are presented.

Some of the larvæ of this interesting genus present structural characters by which they may be divided into two groups: I. With a process or elevation on the eighth abdominal segment. II. Without a process or elevation on the eighth segment. To the first group belong *C. cara*, *hermia*, *amatrix*, *palæogama*, *innubens*, *parta*, etc., all of these having an elevation on the eighth segment, while *C. grynea*, *cratægi*, and *ultronia* have an elongated thorn-like process on that segment. To the second group belong *C. consors*, *badia*, *muliercula*, *antinympha*, *amestris*, *illecta*, *piatrix*, *serena*, *habilis*, *judith*, *viduata*, *neogama*, etc.

The shape and markings of the head afford good specific characters, as may be seen from the accompanying figures.

In raising *Catocala* larvæ, I would recommend wrapping a wet rag, sponge, or cotton around the stems of the food-plant, by which means they can be kept fresh for a considerable length of time. This method is far preferable to putting the stems in wet sand or water. In the latter case the larvæ are apt to get drowned, especially night-feeders which leave their food-plants at dawn, to seek a hiding place at or near the base of the plant. The larvæ of *C. consors*, *badia*, *muliercula*, *antinympha*, and probably others are day-feeders.

Catocala minuta *Edw.*

Before the last Moult. — Head with stripes, which are more confluent on top and at the sides than in front. Body gray, with numerous blackish irrorations. Longitudinal lines very narrow and much broken, sometimes hardly traceable, with the intervening spaces somewhat paler. Eighth segment with the summit of the elevation

whitish. Posterior half of seventh and anterior half of eighth segments at the sides pale gray. Fringes at sides fleshy white. Warts black. Underside white, with a black patch on each segment, between the abdominal legs. Thoracic feet translucent white, with black marks on the outside. Abdominal legs with an inverted, black loop on the outside of each. Length, 25 mm.

Mature Larva. — Head semitranslucent, lilac gray, with whitish dots; sides and top of head black. Body sordid gray, densely covered with minute black dots, giving it a gray appearance. Warts small, with the summits orange. Eighth segment with a rather prominent elevation, black, summit pale. Dorsal warts on the last three segments larger than on the others. Fringes at sides pink. Posterior parts of the segments between the longitudinal lines darker than the anterior half. Underside white, with a large black patch on each segment. Thoracic feet bluish white, each with two black dots outside. Length, 40 mm.

Food-plant. — Honey locust (*Gleditschia triacanthos*).

Catocala micronympha *Guen.*

Fig. 1.

A description of the larva of this species was published by Mr. D. W. Coquillett in 'Papilio,' Volume I, p. 7.

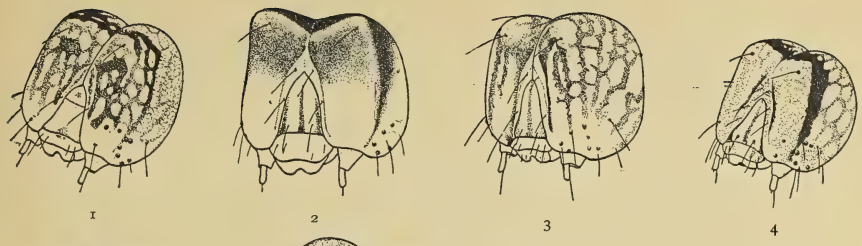
The figure of the head was drawn from an inflated example in the U. S. National Museum.

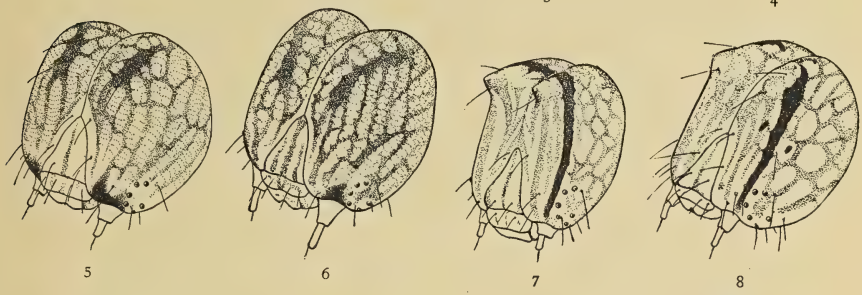
Catocala grynea *Cram.*

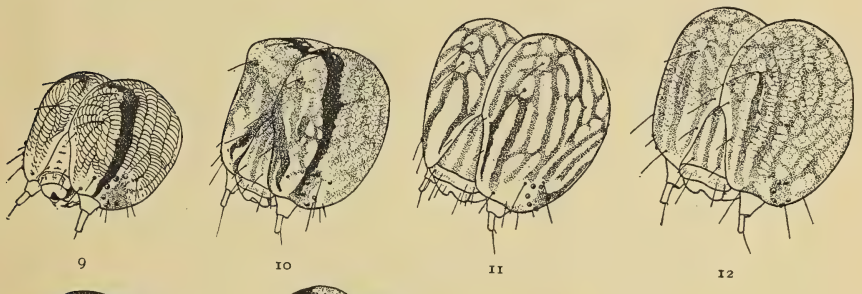
Fig. 2.

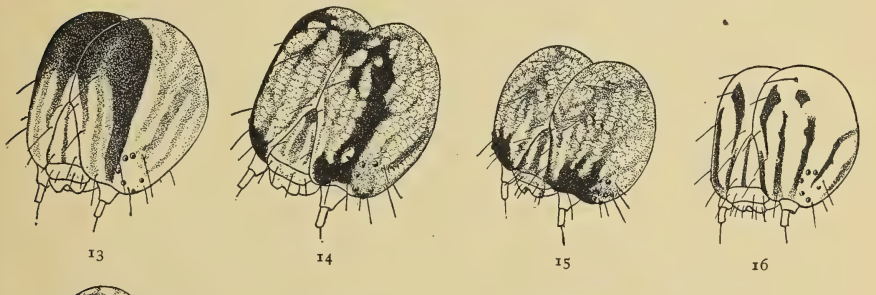
Mature Larva. — Head flattened in front, swollen at sides, deeply incised at the middle on top, each lobe forming a prominent elevation. Pinkish gray, ocher brown on top, including the elevated parts; the triangular frontal piece with three black stripes; mouth-parts pale. Body pale pinkish gray, sparsely covered with minute black dots, which are more numerous on the eighth segment; this segment has a very prominent thorn-like process 1.25 mm. long, red-brown, and directed backwards. Dorsal warts red-brown; the lateral ones obsolete and not visible without a lens. Extreme sides of body pink. Fringes along the sides white. Underside greenish with a large black patch on each of the sixth, seventh, and eighth segments and a smaller one on each of the fourth and fifth segments. First to third segments without patches. Thoracic feet translucent greenish white, pinkish outside and marked with black. Abdominal legs greenish, slightly pinkish outside. Length, 34 mm.

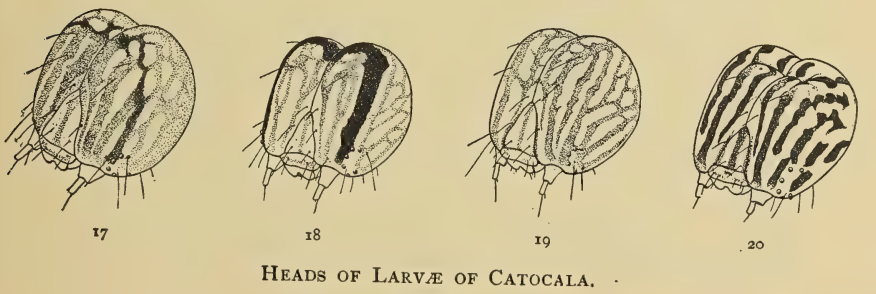
Food-plant. — Apple, thorn (*Cratægus*).











HEADS OF LARVÆ OF CATOCALA.

Catocala amica *Hübner.*

Fig. 3.

Mature Larva. — Head sordid greenish white, inclining to grayish, with confluent, irregular, line-like markings on each side; middle of front without markings. Body dirty grayish white with a somewhat brownish tint, and with numerous black dots, giving the larva a dark appearance. Dorsal warts from the first to fifth segments, black; from the sixth to last segments dull orange on the inner sides. Eighth segment without a prominent elevation or tubercular process, but with a black shade on the junction of the eighth and ninth segments. Warts on the sides pale dull orange. On the subdorsum and sides along the spiracles, the black dots are in form of indistinct shade lines. The last two dorsal warts on the eleventh segment are considerably longer than the rest. Thoracic feet sordid white, translucent, marked with black at the tips. Abdominal legs dirty white, with a blackish loop-like mark on each on the outside. Fringes along sides white. Underside greenish white, with a small black spot on each of the first, second, and third segments, and larger ones on the fourth to seventh segments. Each wart has a short black hair. Spiracles black. Length, 30 mm.

Food-plant. — Oak.

Described from a specimen received from O. C. Poling.

Catocala ultronia *Hübner.*

Fig. 4.

Mature Larva, Dark Form. — Head bilobed on top, flattened in front, pale slaty gray, with paler dots in front and at sides; these dots form clusters at the sides; in front on each side is a broad black band connected on the vertex. Body slaty gray, with numerous blackish dots, hardly visible on the dark ground color. Warts slaty gray, with the tips pinkish; eighth segment with a long, fleshy, thorn-like process, directed backwards. Fringes or filaments along the sides of the body pink. Thoracic feet translucent, greenish, with black marks. Abdominal legs semitransparent, greenish gray with a black, hook-like mark outside of each, the open part downwards. Underside bright rose color with a large black patch on the fourth to the eighth segments inclusive; on the ninth to last segments the patches are dull, rose color. Length, 45 mm.

Pale Form. — Head as in the preceding form. Body dirty whitish gray, covered with numerous black dots or irrorations giving the larva a gray appearance. Along each side of the dorsum is a broad, darker gray longitudinal line, and one on each side along the spiracles. This line is wavy and very much broken. Fringes or fila-

ments pink. On each side of the fourth segment is a pale area, somewhat subtriangular in shape. Process on the eighth segment directed backwards, dirty flesh color. Warts black with pink tips. The pair on the eleventh segment larger than the others, and with a short oblique line directed forwards. Underside bright rose-colored with large black patches. Length, 45 mm.

Food-plant. — Wild cherry (*Prunus serotina*).

The larvæ vary from light to dark gray. Described from specimens received from W. Wassmuth, collected on Long Island, N. Y.

Catocala neogama *A. & S.*

Fig. 5.

Mature Larva. — Head rounded, bilobed; purplish brown with irregular, whitish, contiguous dots and reticulated black lines. The black lines run together on each side of the face below the summit of each lobe, and form a small black patch. On each side above the antennæ is also a small black patch. Body gray with numerous black dots and black markings. Along each side of the dorsum is a broad smoky black line, narrowing and expanding, and enclosing along the dorsum subdiamond-shaped markings, the anterior half of these being somewhat smoky brown gray and the posterior half grayish, crossed by a transverse fold on each segment. On each side along the spiracles is a broad, smoky brown, wavy band. Warts pinkish gray, not prominent. Dorsal pair on the eleventh segment longer than the rest, and on a somewhat ridge-like elevation, directed backwards. Warts along the sides smaller than those on the dorsum. No elevation on the eighth segment. Fringes or filaments along the sides pinkish. Underside rather bright pink, with a black patch on the fourth to seventh segments inclusive, and one on each of the tenth, eleventh, and twelfth segments. Thoracic feet gray-white with black marks. Abdominal legs grayish with dark dots. All the feet and legs are much expanded. Length, 60–70 mm.

Food-plants. — Walnut and hickory.

In the two stages before the last, the caterpillar is somewhat pinkish gray, with the markings and pattern much the same as in the last stage. It may be known readily by the checker-like or subdiamond-shaped markings along the back, caused by the expansion and contraction of the bands. Described from specimens received from W. Wassmuth, collected on Long Island, N. Y.

Catocala viduata *Guen.*

Fig. 6.

Mature Larva. — Head longer than broad, bilobed, pale dirty white with irregular brown lines, more or less connected. On each

side of the face below the summit the markings become confluent, forming a small brown patch. Body light gray with numerous black dots, giving the larva a dark appearance. On each side of the dorsum is a brown longitudinal band, more or less marked with black on the outer parts. A similar wavy band is situated along the sides, and there are indications of another along the subdorsal region. The warts are small and pale, except the posterior pair on the eleventh segment, which are considerably larger. Eighth segment not elevated. Fringes or filaments along the sides pale. Underside pale, whitish, with a reddish patch on each segment. The patches between the abdominal legs are much larger than the remaining ones, and the patches on the fourth to seventh segments inclusive enclose a black mark anteriorly. Thoracic feet rather long, whitish, marked with red. Abdominal and anal legs pale with brown dots and a whitish corneous patch on the outerside of each, marked with reddish. Claspers black. Length, 65–70 mm.

Food-plant. — Pecan hickory, and probably other species of hickory.

Described from two specimens kindly sent me by Prof. Glenn W. Herrick, Agricultural College, Mississippi, and from an inflated specimen in the U. S. National Museum, kindly loaned to me by Mr. Dyar. In general appearance the larva of *C. viduata* resembles that of *C. neogama.*

Catocala cara *Guen.*

Fig. 7.

Mature Larva. — Head purplish, with pale testaceous streaks and spots composed of clusters of small confluent dots or granulations. On each lobe, near the top is a very prominent conical protuberance, giving the head a very striking appearance. On each side of the face is a broad black band, the two meeting at the vertex. Body varying from light to dark clay or wood brown. On each side of the back is a dark, smoky, brown-black, longitudinal band, and a wavy broken one on each side along the spiracles. Warts on the dorsum quite prominent, the posterior pairs more so than the anterior, dull carmine. Eighth segment with a rather prominent, blunt, tubercule-like elevation. Fringes at side sparse, pale. Underside deep orange red, with a large patch between the first, second, and third abdominal legs. Thoracic feet pinkish. Length, 70 mm.

Food-plants. — Willow and poplar.

May be known readily by the two very large protuberances on the head.

Catocala amatrix *Hübner.*

Fig. 8.

Mature Larva. — Head rather small, wood brown with sordid white, broken lines in front, and spots at the sides. A broad black line on

each side in front, scarcely reaching the summit; face flattened, with a short, blunt, tubercule-like prominence on each side near the top. Sides rounded. Body smooth, wood brown, more or less suffused with ocherous, giving the larva a variegated appearance. It is covered with minute black dots, forming a wavy, longitudinal band, along each side of the back and one along each side of the spiracles and another less distinct band below the latter. The second pair of warts on each segment on the back rather prominent, the others small. Eighth segment with a rounded, smooth elevation. Eleventh segment elevated with the two tubercles prominent. Sides densely beset with pinkish fringes. Underside orange with a black patch on each segment; the patches between the abdominal legs larger than the others. Length, 75–80 mm.

Food-plants. — Poplar and willow.

The larva varies from light to dark wood brown. It may be known readily by the suffusion of ocherous shades on the body, which gives it a variegated appearance. Described from many specimens received from W. Wassmuth. Collected on Long Island, N. Y.

Catocala parta *Guen.*

Fig. 9.

Mature Larva. — Head rather small, flattened in front, granular, and with a broad black band on each side, the two meeting at the summit; face and sides varying from pale to dark brown, densely covered with pale dirty whitish patches, composed of clusters of elevated dots or granulations. Body varying from pale to dark wood brown, more or less shaded with black, granulated, and with the segments transversely wrinkled posteriorly. On the eighth segment is a short, blunt, rough elevation. On each side of the back is a more or less distinct, blackish, irregular, broad, wavy band, and there is a similar one on each side along the spiracles. Along the middle of the back is a blackish shade line. In pale larvæ the black bands on the back are darker on the posterior parts of the segments. The first, second, and third segments are transversely wrinkled. Last pairs of warts on dorsum rather prominent, blunt. First pairs very small and obsolete as are also those along the sides. Eleventh segment with a flat ridge-like elevation, directed backwards, and shaded with black at the sides. Fringes at sides pale. Underside rose-colored, with a large black patch on each segment. Thoracic feet translucent, whitish, with pale brown marks. The abdominal legs are the color of the body, with black dots. Length, 70 mm.

Food-plants. — Willow *and poplar.*

Catocala hermia *Hy. Edw.*

Fig. 10.

Dr. H. G. Dyar described the larva of this species from a rather poorly inflated example in the collection of the U. S. National Museum, and from which the figure of the head has been made. Additional fresh material is necessary to give a good description of the color and markings of the larva.

Catocala innubens *Guen.*

Fig. 11.

Mature Larva. — Head somewhat bilobed, pale lilac-white, with numerous irregular, violet-brown lines more or less connected by transverse streaks, especially on top. Lines at the sides oblique; mouth-parts pale, whitish. Body lilac-brown, varying from light to dark, with numerous minute black dots and irrorations. There are also traces of three longitudinal pinkish lines on the back, which become conspicuous and bright on the posterior part of the eighth and anterior part of the ninth segments, which are black on these parts, including the elevation on the eighth segment. At the sides the black dots become confluent and form a broad band on each side of the pink band situated below the spiracles. Anal plates pinkish. Thoracic feet rusty brown, semitranslucent. Abdominal legs violet-brown, with a square rusty brown corneous patch on each. Underside light yellow with a small black spot between each pair of thoracic feet, and a very large patch between each of the abdominal legs. Remaining segments with a small patch on each. No fringes along the sides. Length, 55 mm.

Food-plant. — Honey locust (*Gleditschia triacanthos*).

The larvæ are subject to considerable variation, from light to dark, and the red color between the black stripes on the eighth and ninth segments is sometimes pale flesh-color, and the red line along the sides very pale and hardly traceable. The top of the eighth segment is sometimes yellow. Described from specimens received from O. C. Poling, Quincy, Illinois.

Catocala palæogama *Guen.*

Fig. 12.

Mature Larva. — Head lilac-gray, with whitish gray stripes. Body dark lilac-gray covered with numerous black dots tending to form a black longitudinal line on each side of the dorsum, but very irregularly. Warts rather prominent, red, and white on the sides of the bases. Tenth segment with the dorsal warts more prominent than the rest

and directed backwards, chestnut brown. Warts on the second and third segments white. Warts on the first segment black with white bases. Posterior half of eighth, and anterior half of ninth segments, including the elevation, black; the latter is rugose. Thoracic feet dull pinkish, marked with blackish outside. Abdominal legs pinkish with a black horseshoe mark outside of each. Underside of body dull dirty yellow, with a large black patch on each of the first to seventh segments, and a large dull orange patch on each of the eighth and ninth segments. Tenth and eleventh segments with a small pale brown spot. Fringes along the sides of the body whitish. Length, 55 mm.

Food-plant. — Hickory.

The lilac color of the body is not contrasting, owing to the numerous black dots, giving the larva a blackish gray appearance. The warts are prominent, especially the dorsal ones on the eleventh segment. Described from a specimen received from O. C. Poling, Quincy, Illinois.

Catocala piatrix *Gr.*

Fig. 13.

Mature Larva. — Head rather small, rounded on top, narrower at the mouth; black on top in front on upper half of face, this color running downwards on each side in form of a band; remaining parts of head dull ocherous with paler lines and streaks. Antennæ pinkish. Body somewhat tapering at each end, the middle segments being considerably broader than the rest; smoky brown, more or less varied with ocherous, and covered with numerous black dots. Along the middle of the back is a rather broad, dark band, composed of black dots, a broader one on each side, two similar lines along the spiracles, and a shade band along the abdominal legs. In dark individuals the bands are indistinct but traceable. Eighth segment without elevation. Warts white, distinct, but not prominent, all of equal size. Underside bright salmon-pink with a large black patch on each segment. The patches are connected on the last three segments by a narrow black line. Thoracic feet translucent, white, tinged with rufous outside. Abdominal legs smoky brown outside. Length, 75–80 mm.

Food-plants. — Walnut, hickory, and butternut.

A very characteristic larva, readily known by the predominance of black on the head. Described from specimens received from F. E. Watson, and from others collected by me at Fort Lee, New Jersey.

Catocala serena *Edw.*

Fig. 14.

Mature Larva. — Head rather large, depressed in front, shining lilac-brown, with clusters of granular spots and brown streaks. [A

broad black irregular band on each side in front, becoming broken before reaching the summit of the head. Body smooth, pinkish gray, with numerous black dots, giving it a gray appearance. On each side of the back is a broad blackish line, narrowing at the junctions of the segments, the space between paler. On each side along the spiracles is a broad black line, below which is a pinkish shade with darker dots. Warts very small, scarcely visible without a lens. Eighth segment without an elevation. Underside dirty white, very faintly pink along the middle. Thoracic feet translucent, grayish white, with pinkish marks. Abdominal legs translucent, grayish white; claspers pinkish. Sides without fringes. Length, 58 mm.

Food-plant. — Hickory.

Described from an example kindly sent me by S. M. Dodge, Louisiana, Missouri.

Catocala judith *Strk.*

Fig. 15.

Mature Larva. — Head rough, light gray, with brown, irregular striæ, black on the face about the mouth-parts. Body grayish with numerous black dots, forming a rather broad black shade-line along the spiracles. Eighth segment without elevation. Sides without fringes. Underside of body whitish with a reddish brown patch on each segment; the patches on the eighth to tenth segments paler, and in form of a pinkish line on the first, second, and third segments. Thoracic feet amber brown. All the warts are very minute and hardly visible without a lens. Length, 35 mm.

Food-plant. — Hickory.

Catocala illecta *Walk.*

Fig. 16.

This larva was described by G. H. French (Can. Ent., XXIV, 1892, p. 307), S. M. and E. A. Dodge (Can. Ent., XXXIII, 1901, p. 300), and Dr. Harrison G. Dyar (Proc. Ent. Soc., Washington, IV, p. 327), and by me (Journ. N. Y. Ent. Soc., IX, p. 189).

The head here figured was drawn from specimens sent to me by O. C. Poling, Quincy, Illinois.

Catocala muliercula *Guen.*

Stage V. — Head with alternate black and white lines in front; on top and sides the lines are broken. Antennæ red-brown. Body rather bright violet-gray along the dorsum, somewhat paler along the subdorsum; covered with numerous black dots, which form a very broad band along the sides. Warts slightly elevated, pure white.

Underside yellowish white, with a pure white stripe along each side, limited by a very narrow purplish line outside. A deep black line along the middle, expanding into large patches between the abdominal legs. Thoracic feet rufous. Abdominal legs reddish with a square black mark on the outer side of the last two. No fringes at sides of body, and eighth segment without elevation.

Stage VI. (Fully Grown Larva.) — Head orange with white stripes, broken at the sides and on top. Body with a rather broad orange stripe along the back with numerous black dots; on each side of the back is a rather broad black band, followed by a broad orange space covered with numerous black dots. Sides velvety black with slight traces of orange dots. Posterior half of last segment light brown, with a short white line on each side on the top. Warts clear white. Cervical shield brownish with a white line on each side. Sides without fringes. Underside pale orange-yellow with black dots; a black line along each side, and broad black connected patches along the middle. Thoracic feet dull orange. Abdominal legs dull purplish, with two white lines on each outwardly. Length, 63 mm.

Food-plant. — Wax myrtle (*Myrica cerifera*).

Catocala badia *G. & R.*

Fig. 17.

Mature Larva. — Head orange-brown with or without a deep black band on each side, meeting on the vertex, where it is widest. Face with whitish vertical stripes; sides with oblique stripes. Body pale gray-brown, pinkish-gray, or orange-brown, with numerous minute black dots. Warts pure white, conspicuous. No elevation on eighth segment and without fringes at sides. Underside pale yellowish white, with a conspicuous black line expanding into large patches at the middle of each segment, between the abdominal legs. Abdominal legs pinkish or orange-brown outside, ocherous inside. Thoracic feet reddish or reddish brown. Length, 55 mm.

Food-plant. — Wax myrtle (*Myrica cerifera*) and sweet-fern (*Myrica asplenifolia*).

Catocala consors *A. & S.*

Fig. 18.

Mature Larva. — Head rather small, lilaceous, with a deep black prominent band on each side in front, meeting on the top of the head; sides and front with darker irregular lines; those on the sides oblique. Body smooth, tapering, without prominence on the eighth segment and without fringes at the sides; purplish gray, varying somewhat from light to dark, and covered with numerous black irrorations and

dots which form vague lines, giving the larva the appearance of being very indistinctly striped. Warts pure white, contrasting. Underside whitish, with a faint pink tinge and a black line along the middle, expanding into large patches on the middle of each segment, especially between the abdominal legs, which are pinkish. Thoracic feet pinkish. Length, 60 mm.

Food-plant. — Hickory.

Collected at Woodhaven, Long Island, N. Y., by Mr. Wassmuth and myself.

Catocala antinympha *Hübner.*

Fig. 19.

Stage I. — Head small, shining, very pale amber-yellow-brown; ocelli black, with a few blackish hairs. Body smooth, pale amber-yellow-brown, with longitudinal whitish lines. Anterior parts of body greenish caused by the transparency of the skin showing the food in the crop. First two pairs of abdominal legs absent; the following two pairs well developed, as is also the last pair. Warts black, minute, each with a short, pale hair. Underside of body pale, translucent, whitish, with an amber brown line along the middle. Length, 6 mm. Getting ready to moult June 22; moulted June 23.

Stage II. — Head not glossy as in the last stage, and with whitish stripes. Body darker amber-yellow-brown with the lines yellowish white. First and second pairs of abdominal legs rudimentary, first pair shorter. Length, 10 mm. Getting ready to moult June 24; moulted June 25.

Stage III. — Head white with dark brown stripes. Body with two contiguous brown lines along the middle of the back; then a brown line with the intervening space broad; then equidistant pale yellowish white and honey-yellow lines, at sides where the intervening spaces are yellow. Warts black. First and second pairs of abdominal legs more developed than in the last stage. Length, 16 mm.

Getting ready to moult June 26; moulted June 27.

Stage IV. — Head as in the last stage. Body with six longitudinal brown lines on the back, with the intervening spaces paler. Subdorsum with two very narrow pale brown lines close together in a pale yellow field. Sides black, marked with orange and with broken white spots and lines. Length, 20 mm.

Moulted June 29.

Stage V. — Head as in the last stage. The lines along the back are broader, with the intervening spaces irrorate with black. Subdorsal region clear yellow-white with two narrow brown lines. Sides black, more or less marked with orange-brown and a broken white line. Warts white. Underside yellow, with the black line along the

middle broken into patches, and a narrow brown line on each side. Length, 30 mm.

Stage VI. — Head orange-brown with paler stripes. Body rusty orange-brown, with numerous black irrorations, a shade-line along each side of the back and along the sides. The space between the lines on the back is orange-brown on the posterior half of each segment. Below the line along the sides the body is strongly marked with orange brown. Warts pure white. No fringes or filaments at the sides, and no elevation on the eighth segment. Underside yellow with a series of black patches along the middle, and a narrow brown line along each side. Length, 50 mm.

Food-plant. — Sweet-fern (*Myrica asplenifolia*).

Catocala amestris *Strk.*

Fig. 20.

Mature Larva. — Head yellowish white, with deep black vertical stripes forming irregular oblique stripes, more or less broken, at the sides. Top of head with a transverse deep impression. Body sordid yellowish white with a rufous narrow longitudinal dorsal line, and on each side are six equidistant black lines; the lower one along the spiracles much wider than the others. Sides of body below the spiracles pale yellow with a broken black line. Warts yellow. No elevation on the eighth segment and no fringes at the sides. Cervical deeply cut in the middle, yellowish, with three spots on each side. Underside velvety brown-black, broken with yellowish transverse streaks and marks. Thoracic feet black outside, yellowish inside. Abdominal legs yellowish inside and with a very broad black patch outside. Length, 55 mm.

Food-plant. — False indigo (*Amorpha fruticosa*).

Described from an inflated example in the collection of the U. S. National Museum. Dr. H. G. Dyar also described it in the Proceedings of the Entomological Society of Washington, Volume IV., p. 327.

EXPLANATION OF PLATE LII.

Fig. 1. Head of Larva of *Catocala micronympha.*
Fig. 2. Head of Larva of *Catocala grynea.*
Fig. 3. Head of Larva of *Catocala amica.*
Fig. 4. Head of Larva of *Catocala ultronia.*
Fig. 5. Head of Larva of *Catocala neogama.*
Fig. 6. Head of Larva of *Catocala viduata.*
Fig. 7. Head of Larva of *Catocala cara.*
Fig. 8. Head of Larva of *Catocala amatrix.*
Fig. 9. Head of Larva of *Catocala parta.*
Fig. 10. Head of Larva of *Catocala hermia.*

Fig. 11. Head of Larva of *Catocala innubens.*
Fig. 12. Head of Larva of *Catocala palæogama.*
Fig. 13. Head of Larva of *Catocala piatrix.*
Fig. 14. Head of Larva of *Catocala serena.*
Fig. 15. Head of Larva of *Catocala judith.*
Fig. 16. Head of Larva of *Catocala illecta.*
Fig. 17. Head of Larva of *Catocala badia.*
Fig. 18. Head of Larva of *Catocala consors.*
Fig. 19. Head of Larva of *Catocala antinympha.*
Fig. 20. Head of Larva of *Catocala amestris.*

Article XXIX. — THE EARLIER STAGES OF SOME MOTHS.

By William Beutenmüller.

Deidamia inscripta (*Harris*).

Egg. — Globular, smooth, somewhat flattened below, bright green. Hatched June 4.

Stage I. — Head and body uniform yellowish green, the latter with three rows of very minute warts on each side, each bearing a very short hair. Caudal horn almost as long as the body, black, covered with short hairs. Length, 3.5 mm.; caudal horn 2.5 mm. As the larva grows older there appears on each side a subdorsal, pale yellowish longitudinal line. Length, 7 mm.

Getting ready to moult June 6; moulted June 7.

Stage II. — Head globular, yellowish green, with very short hairs. Body green with a narrow yellowish subdorsal line and seven oblique lateral bands. Numerous rows of granular dots across the body, Dorsal region darker than the sides. Caudal horn black, with a green base. Underside, including the thoracic, abdominal, and anal legs, yellowish green. Length, 14 mm.; caudal horn, 3 mm.

Getting ready to moult June 10; moulted June 11.

Stage III. — Head globular, finely granulate. Body slightly darker, with transverse rows of yellow dots on the dorsal region, between the subdorsal yellow lines. Numerous yellow dots also along the sides. Oblique lateral stripes very distinct. The subdorsal line runs from the anterior edge of the first segment to the base of the caudal horn, which is black, green at the sides to about the middle. Spiracles black. Underside and legs uniform green. Thoracic feet yellowish green. Length, 18 mm.

Getting ready to moult June 12; moulted June 13.

Stage IV. — Head green with a yellow vertical stripe on each side of the face. Body, with the rows of transverse wrinkles, subdorsal line, and oblique lateral bands, bright yellow. Length, 30 mm.

Getting ready to moult June 16 and 17; moulted June 17 and 18.

Stage V. — Head and body green with seven oblique lateral bands, subdorsal lines, and a medio-dorsal line bright yellow. The transverse wrinkles on the dorsal region are broken by the medio-dorsal line, and the lateral bands are broken by the green ground color. Underside uniform green. Thoracic feet yellow. Caudal horn yellowish green. Length, 58 mm.

Food-plants. — Grape, Virginia creeper (*Ampelopis quinquefolia*), and Japanese ivy (*Ampelopsis vetchii*).

Sphinx eremitus *Drury.*

Egg. — Pale milky white, longer than broad or high, smooth, shining. Length, 1.33 mm.; width, 1.2 mm.; height, 1 mm.; Hatched July 15.

Stage I. — Wholly pale whitish green. Caudal horn black with two fine, short setæ at the tip. On the second segment is a short, pointed process directed forwards, pale whitish green with the tip black. Length, 9 mm.

Stage II. — Head small, granulate. Body whitish green, covered with fine granulations above, darker beneath. There are also traces of a subdorsal line. Sides with seven rather broad oblique bands. Second segment with the process more developed than in the last stage. Caudal horn black, covered with very short spines. Tips of thoracic feet brown. Length, 14 mm.

Moulted July 22.

Stage III. — Whitish green, granulated. Oblique lateral bands very broad, and hardly visible on the pale ground color. Caudal horn black. Process on second segment black with whitish spines towards the tip. Length, 18 mm.

The succeeding stages were not observed.

Lepisesia gauræ (*A. & S.*).

Mature Larva. — Head yellowish green, with a small black dot at the lower part of each side. Mouth-parts pitchy brown. Body smooth, yellowish green, with a row of black spots along the middle of the dorsum, absent on the second and third segments. On each side of the dorsum is a very broad reddish band, composed of elongate marks, broadest on the anterior parts of the segments, and disconnected on the junctions of the segments; especially so on the first to fifth. A series of reddish brown, oblique, elongate marks along each side, one to each segment, and behind each two small blackish spots. On each side below is a similar series of reddish brown marks, forming a band on the last three segments; on the fore part of each mark is a black spot. Along the middle, below, a row of large reddish brown patches. Abdominal legs reddish at tips. Thoracic feet yellow, tips black. Caudal horn black, base yellowish green. Length, 60 mm.

Food-plant. — *Epilobium.*

Described from inflated specimens collected in Harris Co., Texas.

Lepisesia juanita (*Strecker*).

Mature Larva. — Head reddish, smooth. Body reddish brown with a pale yellowish line on each side along the subdorsum, crossed on the anterior part of each segment by an oblique mark composed of dots of the same color. This line runs from the anterior part of the second segment to the end of the tenth segment. Along each side

below the spiracles is a broad yellowish white longitudinal band, running from the head to the end of the eleventh segment. On the anterior and posterior parts of each segment are transverse rows of black dots, and rows of dots at the sides but not extending to the top of the segments, thus leaving a somewhat rounded area on top of each segment. Last two segments without black dots. Eleventh segment with a glassy, eye-like spot, containing a short tubercle in the middle and ringed with yellowish white and black. Spiracles in a small black spot. Underside and feet wholly reddish. Length, 60 mm.

Food-plant. — *Epilobium.*

Described from an inflated specimen collected in Harris Co., Texas.

Pseudanthrœcia coracias (*Guen.*).

Stage I. — Head and cervical shield very pale testaceous, shining; ocelli black. Body shining, greenish dorsally, especially so on the first to sixth segments inclusive, and with rather indistinct, whitish, longitudinal lines; intervening spaces pale greenish testaceous. Warts black. First pair of abdominal legs absent; second pair rudimentary; third and fourth pairs well developed. Underside similar to the upper. Length, 5 mm. Moulted June 19 and 20.

Stage II. — Head pale testaceous with whitish vertical lines. Body greenish on the fourth and fifth segments; remaining segments pale testaceous, with narrow whitish lines. The first pair of abdominal legs now present but rudimentary; the second pair slightly more developed; third and fourth pairs well developed. Warts and setæ black. Underside with a large brown patch on each segment. Length 10 mm.

Moulted July 21 and 22.

Stage III. — Head white with broken brown lines in front and reticulations of the same color at the sides. The body is now darker brown along the sides and pale yellow-brown on the second and sixth to last segments; greenish on the third, fourth, and fifth segments. The white stripes are more distinct, equidistant at the sides; the space on the dorsum broadest. Warts and setæ black. First and second pairs of abdominal legs more developed than in the preceding stage. A black line along the venter, expanding into patches on the sixth and seventh segments. Thoracic feet and abdominal legs pale yellowish. Length, 15 mm.

Moulted June 23 and 24.

Stage IV. — Head similar to that of the last stage. Body yellowish with white lines; lateral parts below spiracles deep brown. Second to fifth segments inclusive greenish dorsally. First pair of abdominal legs short; second pair well developed, but shorter than the third and fourth pairs. Underside same as before. Length, 20 mm.

Moulted June 25 and 26.

Stage V. — Very much like the last stage, but the body is somewhat variable in color, yellow or yellowish along the dorsal region, with white lines and dark irrorations on the yellow intervening spaces. The line on the subdorsum limited above with a more or less perfect brown line. Sides thickly speckled with white on a dark ground, and along which runs a whitish and brown line. Eleventh segment with an oblique elevation directed backwards. First pair of abdominal legs short; the remaining ones well developed. Length, 31 mm.

Moulted June 28 and 29.

Stage VI. — Head brown with sordid white spots, and two more or less distinct dark brown streaks on each side in front. Body narrow, tapering, varying from green to brown and black, more or less covered with black dots and irrorations. The narrow lines are not distinct; the two on the dorsum most conspicuous, those on the subdorsum and sides quite indistinct. Warts small, white. Eleventh segment elevated, but not prominently, with two blunt tubercles. Spiracles black. Underside dirty yellowish with a very broad band along the middle. Thoracic feet dirty whitish. Length, 40 mm.

Food-plant. — Locust (*Robinia pseudacacia*).

When at rest the fore part of the body is raised upward, with the head and first and second segments curled downward.

Article XXX. — NOTICE OF A NEW GENUS OF MARINE ALGÆ, FOSSIL IN THE NIAGARA SHALE.

By R. P. Whitfield.

Plate LIII.

In Volume XXXIX of the Proceedings of the Academy of Natural Sciences of Philadelphia for 1888, page 131, Dr. Ringueberg describes a fossil under the name *Inocaulis anastomotica*, of which the Museum possesses three individuals. Two of these are in the James Hall Collection and the third, by much the best preserved individual, is from the collection donated to the Museum by the late John J. Crooke, formerly of this city and Staten Island.

The specimens under consideration in the Hall Collection have been associated with and considered as examples of *Dictyonema retiformis* Hall, from which they differ materially on close examination. The Crooke specimen has been in the Museum collection some years, but was so heavily coated with varnish that but little importance had been attached to it, until after freeing it from this coating it is found to be a remarkably fine individual, showing features so similar to dried examples of *Fucus* that it at once attracts attention.

The organism is so unlike *Inocaulis* that I have considered it more natural to place it among the marine algæ, but finding no genus of fossil alga that will correspond to it, I have concluded to propose for it the new name *Palæodictyota* from its strong similarity to the living form *Dictyota* Lameroux.

Palæodictyota, new genus.

Frond flat or funnel-shaped (flat only from disruption). Branches compressed, membranaceous, much wrinkled on the surface; decompoundly branched with occasional anastomosings of the edges; extremities of branches showing two and occasionally three points; older stipes two or three mm. wide, above one mm., and near the outer extremities often only points.

Geological horizon, Niagara Group.

Dr. Ringueberg described this form as cited above in 1888, but in tracing out its affinities I find that in May, 1884, in Bulletin No. 1, Vol. I, of the State University of Missouri, Dr. J. W. Spencer described and figured the same thing under the name *Inocaulis ramulosus*, in an article on Graptolites, from specimens obtained from the Niagara Group at the 'Jolly-cut,' Hamilton, Ont.

There can be no question as to the distinction between the present forms and the true *Inocaulis*, the types of which are before me, as the specimens on which that genus was founded present such a distinctive feature in being covered on the surface with fine setæ, like short stiff hairs, which show so distinctly on the edges of the stipes as to present the appearance of a much worn surface of a specimen of *Stenopora*. Although the substance when present has the same carbonaceous Graptolitic character as in this form, the mode of growth is very distinctive.

In comparing the present form with *Dictyonema*, with which it is associated in the shale beds, it is found to be much more flexuose in its growth and stronger than *D. retiformis*. Besides it is destitute of the ridged straight radiating bars of *Dictyonema* and the connecting bars between the rays, leaving the quadrangular spaces or openings between.

The Museum possesses the three individuals above mentioned. Two of these are fragments only and are flattened on the shale; the third one presents an oval disc of eight and a half by about ten and a half cm. in dimensions with the central portion or base of the frond forming a deep gash on the surface where it passes into the shale below. From this depression the stipes radiate on all sides to the outer margin of the disc, but the substance of the specimens has been mostly removed, leaving only the imprint, preserving the characteristic wrinkling of the surface, like that on the bark of a dried twig.

Formation and Locality.—In the shales of the Niagara Group at Lockport, N. Y., associated with the two species of *Dictyonema*, *D. gracilis* and *D. retiformis* Hall, and with *Inocaulis plumulosus* Hall.

1

2

Palaedictyota ramulosa *Spencer sp.*

Heliotype Co, Boston.

Article XXXI. — ON JURASSIC STRATIGRAPHY ON THE WEST SIDE OF THE BLACK HILLS — SECOND PAPER ON AMERICAN JURASSIC STRATIGRAPHY.

By F. B. Loomis.

Plates LIV and LV.

During June, 1901, a party, sent out by Professor Osborn, from the American Museum of Natural History, prospected the Jurassic exposures of the west side of the Black Hills for Dinosaur remains. In connection with this work sections were made by the writer at six of the best and most characteristic exposures, to show the stratigraphy of these deposits. These were made at Professor Osborn's request for comparison with the sections previously made by the writer in the Como district of Wyoming.

The area covered extends from a little north of Hulett to fifteen miles south of Newcastle; the exposures stretching some 125 miles in length, and varying from a fourth of a mile to ten or twelve in width. The distribution of the Jurassic in the region is shown in the map accompanying the paper, as is also the location of the individual sections. The Jurassic is exposed mostly in escarpments, capped by the heavy Dakota sandstone, which makes the 'rim.' These escarpments generally face toward the centre of the Hills and continue on around the north and east sides as well as on the west side. The soft clays which predominate in the Upper Jurassic are the cause of a considerable valley all around, just inside the 'rim.' The strata dip in varying degrees away from the centre of the Hills, but are in the best exposures nearly horizontal.

The Jurassic is divisible into two parts: a lower marine, corresponding to Knight's Shirley [1]; and an upper fresh or brackish water corresponding to Scott's Como.[2] On the east

[1] W. C. Knight, 'Jurassic Rocks of Southeastern Wyoming,' Bull. U. S. Geol. Surv., Vol. XI, pp. 377–388.
[2] W. B. Scott, Introduction to Geology, p. 447 (footnote).

side of the Hills, a thick bed of sandstone immediately overlies the Triassic; but this bed is everywhere lacking on the west side of the Hills, the transition being uninterrupted, and seen only in the change from sandy red clay to sandy green clay.

On comparing the sections made on the east side of the Hills,[1] these on the west side, and similar sections made in central and eastern Wyoming,[2] it becomes clear that the Jurassic of the west side corresponds more closely with that in central Wyoming (especially on the Medicine and Como anticlines) than the west side corresponds to the Jurassic on the east side of the Black Hills. However, the upper or freshwater beds of the east and west sides correspond with one another better than the marine layers. Many of the most striking layers of the west side can be detected in the centre of Wyoming almost exactly as they occur in the Hills. To bring this out strongly, in the table where the sections are set side by side, the same series of numbers is used as in the table [3] of sections from central Wyoming, and such layers as are recognized as being equivalent are printed in heavy type.

The Triassic of the west side of the Black Hills is made up of barren red sandy clay. This grades into the green sandy clay of the base of the Shirley, which for some eight to ten feet is also barren. Here, however, *Belemnites densus* begins to appear in great abundance. This clay is then the equivalent of and like in texture to the Belemnites layer further west (No. 2). The upper part of the layer may carry thin beds of limestone as in the Inyan Kara Peak section. This is overlaid by a layer of green clay with large limestone nodules (No. 4), which vary in size from six inches to a couple of feet in diameter. It is in and on just such nodules that *Baptanodon* remains are found in the centre of the State. The layer was everywhere [4] present both on the west and east sides of the Hills. However, no trace of *Baptanodon* was found in any of the exposures; but in the stone-pile of a yard on Miller Creek,

[1] The east side sections are in manuscript; they were made by G. R. Wieland, and verified by myself.
[2] Loomis, Bull. Amer. Museum. Nat. Hist., Vol. XIV, pp. 189–197.
[3] Last cit., p. 192.
[4] Except in the Salt Creek section, which is an unusual one.

two or three *Baptanodon* vertebræ were discovered, and probably came from this horizon in some of the nearby exposures. In the centre of Wyoming this layer has a purple hue, but is otherwise similar.

A sandy limestone or shell sandstone (No. 5) usually follows, which carries several invertebrate marine forms. At the Belle Fourche station, this layer held *Amaltheus cardiformis*, *Ægoceras tumidus* v. Buch, *Ostrea strigulecula* W., *Tancredia inornata* M. & H., *Pseudomonotis curta* W., *P. orbiculata* W., *Dosinia jurassica* W., *Trigonia* sp., and *Pholadomya* sp. This fauna with some variations is widely distributed at this horizon.[1]

From this horizon to the top of the marine Jurassic there is no uniformity in the character of the beds, usually, as in the Belle Fourche section, the clays alternating rapidly with thin beds of sandstone. The Salt Creek section has soft sandstones alternating with denser ones. The Beaver Creek section has nothing to represent the alternations. In central Wyoming there are several clays and sandstones. There is no uniformity except in the rapidly changing character of the deposits.

The top of the marine beds is a green clay (No. 12) of varying texture. The change to fresh- or brackish-water is a gradual one, so that a distinct boundary is difficult to find, but this bed is the highest in which any trace of marine life was found, and is, therefore, used here as a convenient separating horizon.

The base of the freshwater deposits is a bed of sandstone (No. 13), varying greatly in thickness and in character.

No. 14 is a layer of green clay, the lowest in which any traces of Dinosaurs were found. On the north side of Inyan Kara Peak a few fragments of sauropod limb bones occurred; and near the Sheldon P. O. section a few foot bones were found at this level. At the Belle Fourche station traces of Dinosaurs also occurred. In all cases the bones were uniformly hard, but very scarce.

[1] At the Sheldon P. O. station there occurred *Camponectes platissiformis* W., *Tancredia warreni* M. & H., *T. bulbosa* M. & H., *Avicula mucronata* W., and *Ostrea strigulecula* M. & H. The Kara Peak section had *Amaltheus cardiformis* M. & H., *Ægoceras tumidus* v. Buch, and *Pseudomonotis curta* W

The Inyan Kara Peak section is remarkable for its thickness. This is most marked in the No. 15 bed of sandstone which is here 75 feet thick. The layer is very generally a fairly heavy one and occurs in all the sections.

Next follow several thin layers of variable character, consisting of clays, sandstones and limestone concretions. There is no constant bed till No. 22 is reached, which is a band of maroon clay filled with tiny concretions. It is present in three of the sections and occupies the same position as a similar band in the centre of Wyoming. It is a very good horizon marker, being so distinctive in texture and conspicuous in color. Just above a very constant layer of limestone nodules (No. 23) occurs.

The layers from 24 to 28 are a series of brilliantly colored clays, red, purple, and green in color, and popularly called the "varigated clays." These clays have occasional beds of limestone nodules. In the variegated beds, especially toward the top, Dinosaur remains are not infrequent, but without exception the bones are in a wretched state of preservation, the iron in the colored beds having eaten into them till great spots are mere powder. In all the sections some traces of Dinosaurs were found at this horizon, but they were especially abundant along the lower reaches of the Inyan Kara Creek. On Inyan Kara Creek in these same beds Mr. Thompson found several specimens of *Unio baileyi* L. and *Valvata leei* L. similar to those found by Logan in the Freezeout Mountains. These variegated clays occur on the east side of the Hills, as well as on the west side, also in the Freezeout Mountains, and in the southeastern part of Wyoming.

The top of the freshwater series is everywhere a bed of olive-green clay of considerable thickness, in which Dinosaur remains are extremely rare, but do occur; and where present, the bones are in a good state of preservation. Fragments were found at the Belle Fourche station and near Inyan Kara Peak. The whole is capped by the heavy bedded Dakota sandstone. The sections are often complicated by this sandstone faulting and slipping part way down the slope of the escarpment. In fact the greatest care is required to find ex-

posures where more or less of the face has not faulted and slipped to some extent. The majority of all the Dinosaur prospects were in clays which were faulted out of place.

Of all the sections the Inyan Kara Peak one is the thickest. This is due in great part to the frequency and extra thickness of the sandstones. The Beaver and Salt Creek sections in the same general neighborhood also have larger quantities of sandstone, which fact I take to mean that in the neighborhood there was some land mass during a part at least of the Jurassic period.

EXPLANATION OF THE PLATES.

Fig. I, Map of the country on the west side of the Black Hills, covered by the prospecting party of the American Museum of Natural History in June, 1901.

Line A–B, Belle Fourche Section.
C–D, Inyan Kara Creek Section.
E–F, Sheldon P. O. Section.
G–H, Inyan Kara Peak Section.
I–J, Salt Creek Section.
K–L, Beaver Creek Section.

The map is modified from Scott's Mineral and Geological Map of the Black Hills.

Fig. II, Belle Fourche Section.

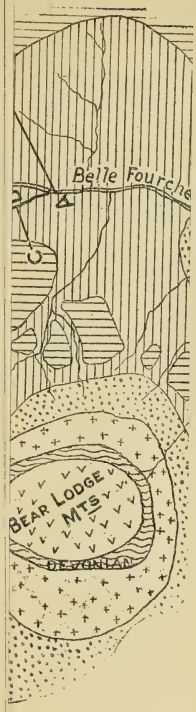
The vertical and longitudinal enlargements are the same in all the sections.

Fig. III, Inyan Kara Creek Section.
Fig. IV, Sheldon P. O. Section.
Fig. V, Inyan Kara Peak Section.
Fig. VI, Salt Creek Section.
Fig. VII, Beaver Creek Section.

		BELLE FOURCHE SECTION.		INYAN KARA CREEK SECTION.		SHELDON P. O. SECTION.	
			Ft.		Ft.		Ft.
	31	Dakota sandstone...	180+	Dakota sandstone...	80+	Dakota sandstone...	50+
Freshwater Jurassic.	30	Olive-green clay....	70	Olive-green clay....	40	Olive-green clay....	30
	29			Light green clay....	12		
	24 — 28 Variegated Clays	Yellow-green clay with small concretions.....	12	Maroon clay with small concretions. Green clay with small concretions.	10 5		
				Red clay.....	5	Limestone concretions.....	1
				Green clay.....	5	Green clay.....	10
		Maroon clay.....	10	Maroon clay.....	6	Maroon clay.....	5
		Green clay.....	6	Green clay.....	20	Yellow-green clay...	9
						Red clay.....	5
	23	Limestone concretions.....	1	Limestone concretions.....	1	Limestone concretions.....	
		Green clay.....	6			Green clay.....	8
	22	Maroon clay with small concretions.	6			Limestone concretions.....	1
	21	Green clay with small concretions.....	10			Red clay.....	3
	20			Yellow sandstone...	9		
				Dense gray sandstone.....	8		
	19	Limestone concretions.....	1				
		Green clay.....	4			Green clay.....	12
	18						
	17						
	16	Limestone concretions.....	1			Limestone concretions.....	1
		Green clay.....	6			Green clay.....	12
	15	Soft yellow sandstone.....	2	Yellow sandstone..	5		
	14	Green clay.....	7	Limestone concretions.....	1		
	13	Soft yellow sandstone.....	2	Yellow sandstone...	12	Gray sandstone.....	2
	12a			Limestone concretions.....	1		
Marine Jurassic.	12	Green clay weathering brown.....	25	Green clay.....	8	Yellow-green clay...	2
		Limestone concretions.....	1	Gray sandstone.....	2		
		Green clay weathering brown.....	20	Green clay with nodules.....	6		
	11	Gray sandstone....	2	Soft sandstone.....	10	Soft sandstone.....	10
	8	Green clay.....	10				
	7	Gray sandstone.....	2	Gray sandstone.....	4		
		Green clay.....	7	Olive clay.....	5		
		Gray sandstone.....	1	Sandstone with shells.....	2		
		Green clay.....	4	Olive clay.....	5		
		Gray sandstone.....	1	Sandstone with shells.....	2		
		Green clay.....	6	Olive clay.....	5		
		Gray sandstone.....	1	Gray sandstone.....	2		
	6	Sandy clay.....	14				
	5	Shell limestone.....	3				
	4	Sandy clay.....	10	Olive clay.....	1+	Olive-green clay with nodules.....	35
						Concretions.....	1
						Olive-green clay with nodules.....	12+
	2	Green clay with Belemnites densus	20+				
	1a						
	1	Total..	271+		191+		159+

Note.—Numbers in heavy type indicate that the layer can be recognized in the centre of Wyoming

	KARA PEAK SECTION	Ft.	SALT CREEK SECTION.	Ft.	BEAVER CREEK SECTION.	Ft.
31	Dakota sandstone..	15+			Dakota sandstone..	20+
30					Brown-green clay..	15
29					Olive-green clay....	66
28 — 24 Variegated Clays					Green clay with small concretions.....	15
					Maroon clay with small concretions	6
	Red clay.....	3				
	Green clay.....	3			Green clay.....	15
	Cream sandstone...	8				
	Blue-green clay.....	6				
	Red clay.....	1				
23	Limestone concretions.....	1				
	Purple clay.....	3			Maroon clay with small concretions.	12
22	Red clay.....	2			Green clay.....	6
21	Cream sandstone...	2				
20						
19						
	Green clay.....	3				
18	Cream sandstone...	2				
17	White sandstone....	11				
	Black clay.....	2				
16					Limestone concretions	1
	White sandstone....	8				
15	Yellow sandstone...	75	Dark red sandstone	20		
14	Slate-green clay....	50			Olive-green clay....	8
13	Gray sandstone.....	15			Buff sandstone.....	12
12a			Olive-green clay with Belemnites densus	12	Green clay with gypsum.....	20
	Yellow-green clay..	6				
12			Pink sandstone.....	8	Gray sandstone....	1
	Olive-green clay....	6	Buff sandstone.....	4		
11			Soft pink sandstone	4		
8			Dense buff sandstone	15		
	Sandstone.....	1	Soft buff sandstone.	8		
	Green clay with nodules.....	3				
7	White sandstone....	12	Buff sandstone.....	8		
6						
5						
	Green clay with nodules.....	12				
4	Soft gray sandstone.	8				
	Green clay with nodules.....	82			Green clay with nodules.....	30
	Belemnites densus bed	2				
	Green clay.....	20	Olive-green clay....	35	Olive clay with Belemnites densus	60
2	Belemnites densus bed	10				
	Limestone layer....	½				
	Sandy green clay...	16			Sandy green clay...	10
1a			Gypsum	3		
	Total.....	373½	.....	117	277	
1	Red Triassic sandy clay.....	50+	Red Triassic sandy clay.....	90+	Red Triassic sandy clay.....	40+



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10

OURCHE SE

24. Olive clay
Sandstone with
marine shells

KARA CRE

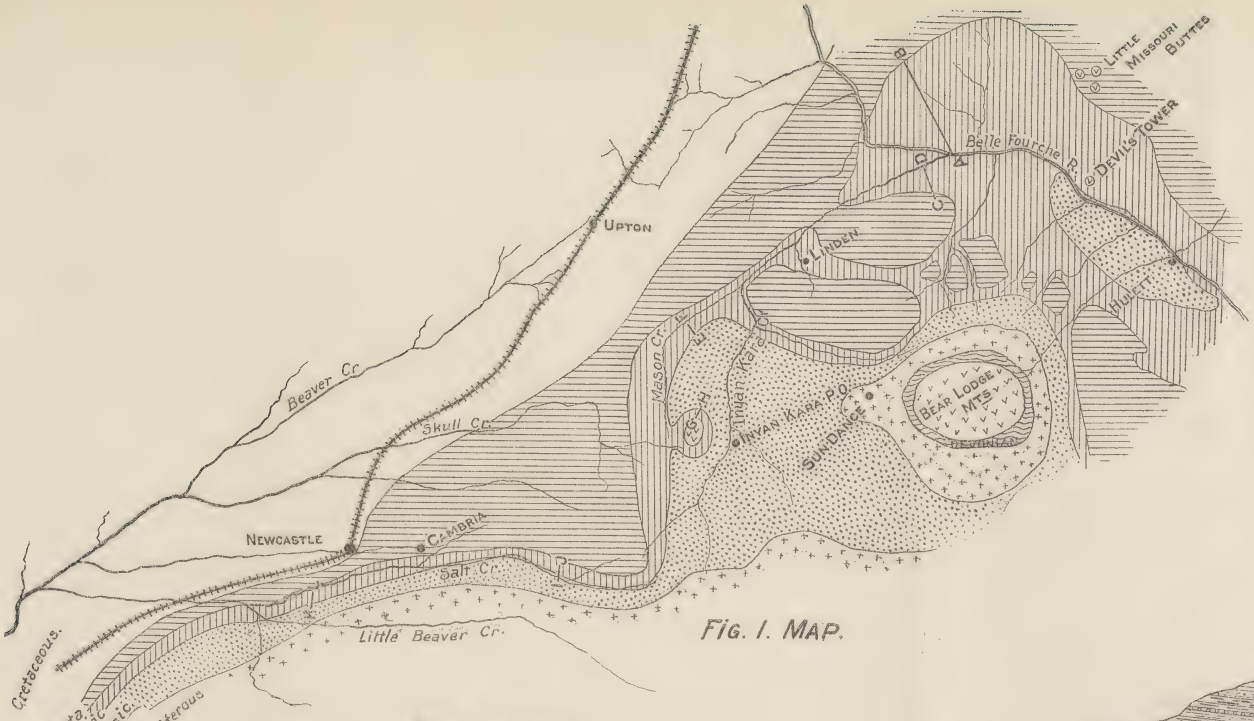


FIG. I. MAP.

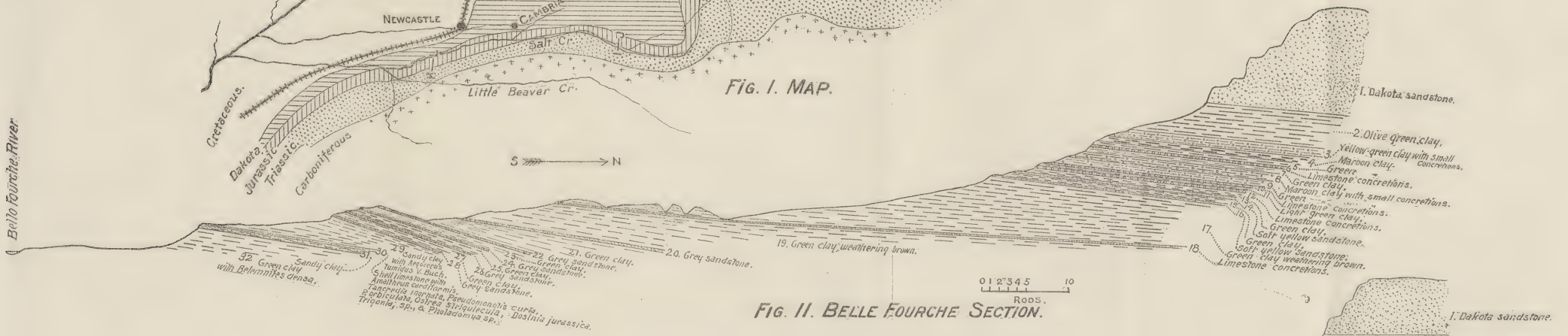

Belle Fourche River
1. Dakota sandstone.
2. Olive green clay.
3. Yellow-green clay with small concretions.
4. Maroon clay.
5. Green "
6. Limestone concretions.
7. Green clay.
8. Maroon clay with small concretions.
9. Green "
10. Limestone concretions.
11. Light green clay.
12. Limestone concretions.
13. Green clay.
14. Soft yellow sandstone.
15. Green clay.
16. Soft yellow sandstone.
17. Green clay weathering brown.
18. Limestone concretions.
19. Green clay, weathering brown.
20. Grey sandstone.
21. Green clay.
22. Grey sandstone.
23. Green clay.
24. Grey sandstone.
25. Green clay.
26. Grey sandstone.
27. Green clay.
28. Grey sandstone.
29. Sandy clay with Ammonites Tumidus V. Buch.
30. Shell limestone with Amalthous conformis, Taggerella impressa, Pseudomonotis curta, Belemnites densa, Sandy clay.
31. Green clay with Belemnites densa.
Rhynchonella Varians, Ostrea Strigulecula, Terebratula, Ostrea Strigulecula, Trigonia, sp.? & Pinaladomya sp.
Dosinia jurassica.
0 1 2 3 4 5 10
Rods.

FIG. II. BELLE FOURCHE SECTION.

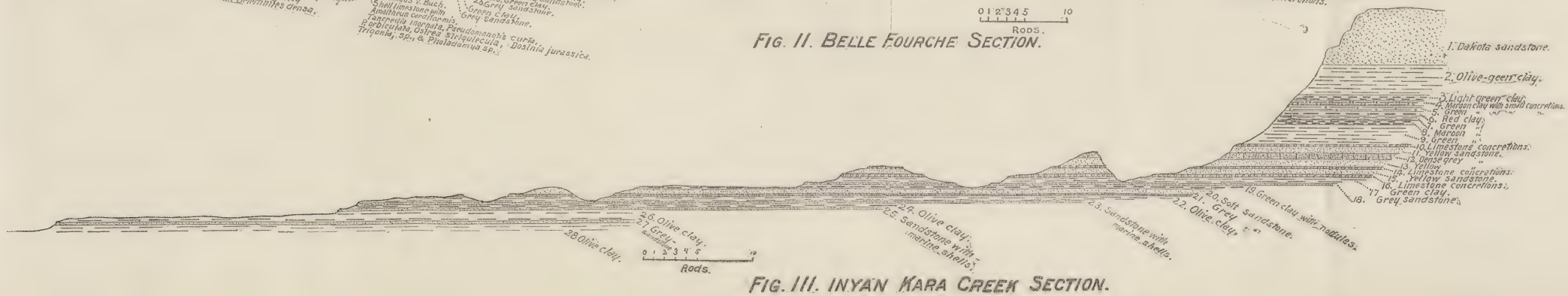
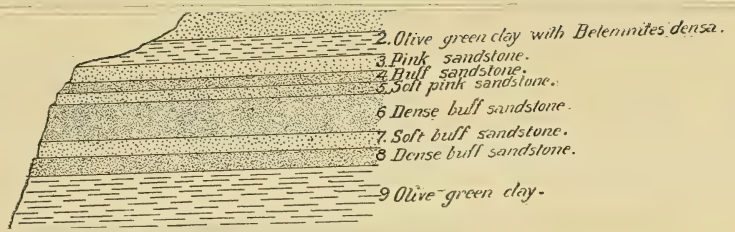


FIG. III. INYAN KARA CREEK SECTION.


2. Olive green clay with Belemnites densa.
3. Pink sandstone.
4. Buff sandstone.
5. Soft pink sandstone.
6 Dense buff sandstone.
7. Soft buff sandstone.
8 Dense buff sandstone.
9 Olive-green clay.

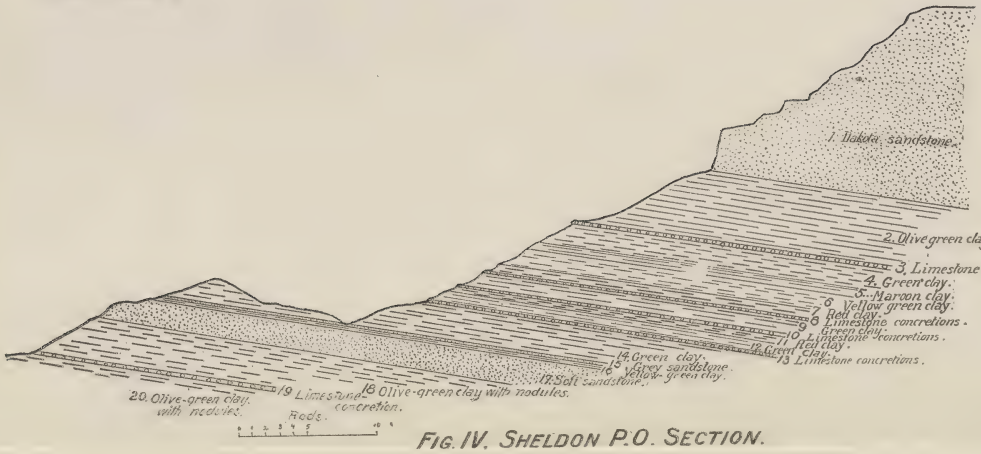


FIG. IV. SHELDON P.O. SECTION.

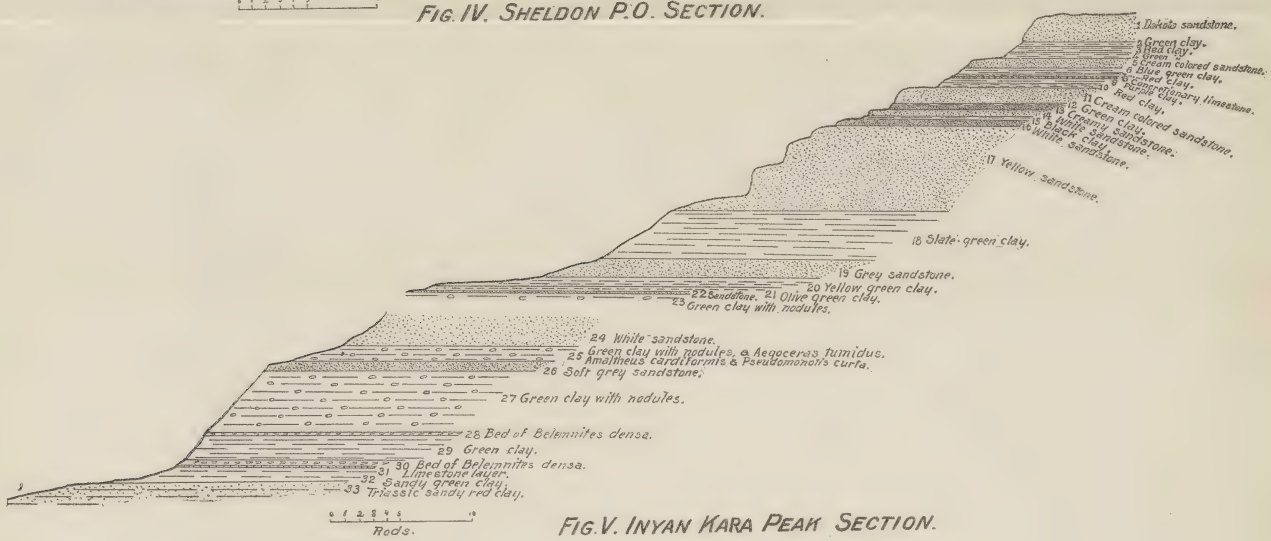


FIG. V. INYAN KARA PEAK SECTION.

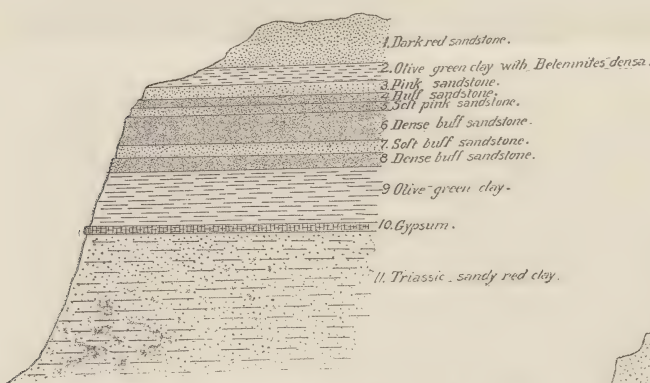


FIG. VI. SALT CREEK SECTION.

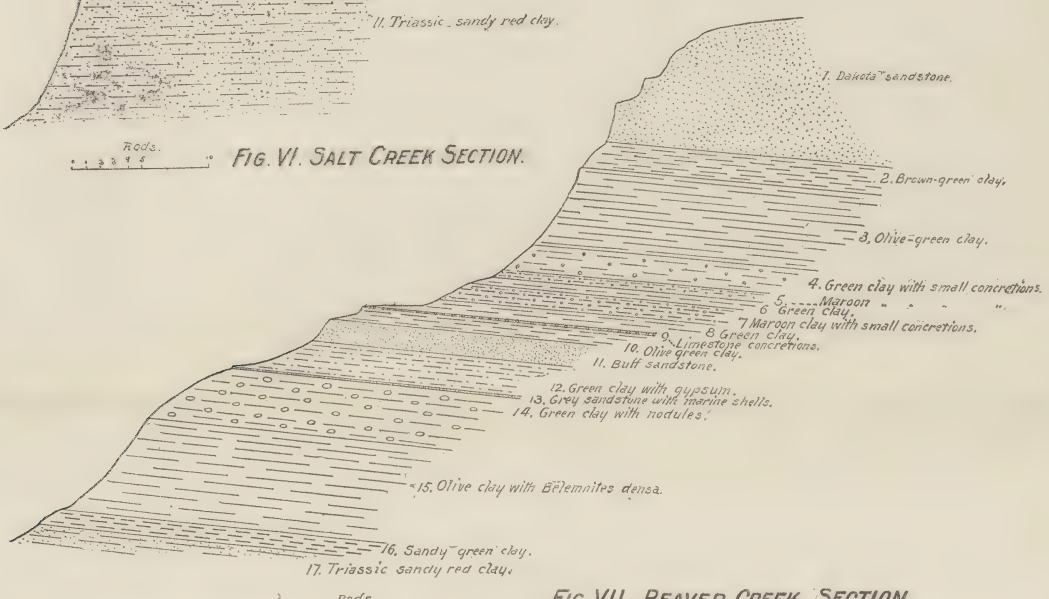

1. Dakota sandstone.
2. Brown-green clay.
3. Olive-green clay.
4. Green clay with small concretions.
5. Maroon " " " "
6. Green clay.
7. Maroon clay with small concretions.
8. Green clay.
9. Limestone concretions.
10. Olive green clay.
11. Buff sandstone.
12. Green clay with gypsum.
13. Grey sandstone with marine shells.
14. Green clay with nodules.
15. Olive clay with Belemnites densa.
16. Sandy-green clay.
17. Triassic sandy red clay.
Rods.

FIG. VII. BEAVER CREEK SECTION.

Article XXXII. — A NEW CARIBOU FROM ELLESMERE LAND.

By J. A. Allen.

The valuable natural history material brought by the Arctic explorer, Commander R. E. Peary, U. S. N., to the American Museum of Natural History on his return from his recent long sojourn in the high North contains five specimens of Caribou taken in Ellesmere Land, Lat. 79°, in June, 1902. They comprise four flat skins of adults without skulls, and more or less defective, and the complete skin of a young fawn. In coloration they are strikingly different from any other known Caribou, being pure white except for a large dark patch on the middle and posterior part of the back.

Rangifer pearyi, sp. nov.

Ellesmere Land Caribou.

Type, No. 19231 ♂ ad., Ellesmere Land, N. Lat. 79°, June 15, 1902, Commander Robert E. Peary, U. S. N.

Entire animal pure white except an oval grayish brown patch over the posterior half of the dorsal surface, gradually fading into white towards the shoulders, the hair being white to the base, or of a pale shade of lilac below the surface, where the surface color is white. The dorsal patch occupies an area of about 670 mm. in length by 350 mm. in width, and is drab-gray, divided by a very narrow median line of white. The legs and feet are wholly white; the ears are slightly tinged with gray, the hair beneath the surface being plumbeous and showing slightly at the surface. The antlers are just budding, being represented by small protuberances, about an inch and a half in length, covered with short hair. Total length of flat skin, 1660 mm. Corresponding measurement of flat skins of the dark form of Caribou from Greenland, 1820 mm.

A female (No. 19232) is similar, except that the dark dorsal area extends a little further forward at the shoulders, and is a little darker. As in the male, the patch fades out to whitish toward the shoulders. Length of the flat skin, 1560 mm.

Two other females are similarly marked, but the dorsal patch in both is much darker, approaching dark slate gray. The region around the base of the antlers and ears is clouded with grayish, as are the edges of

the ears; the front surface of the forelegs is dark grayish brown, and of the hind legs faint buffy grayish brown, increasing in amount and intensity apically from the tarsal joint to the hoofs. These skins measure respectively 1610 and 1570 mm. in total length. In one

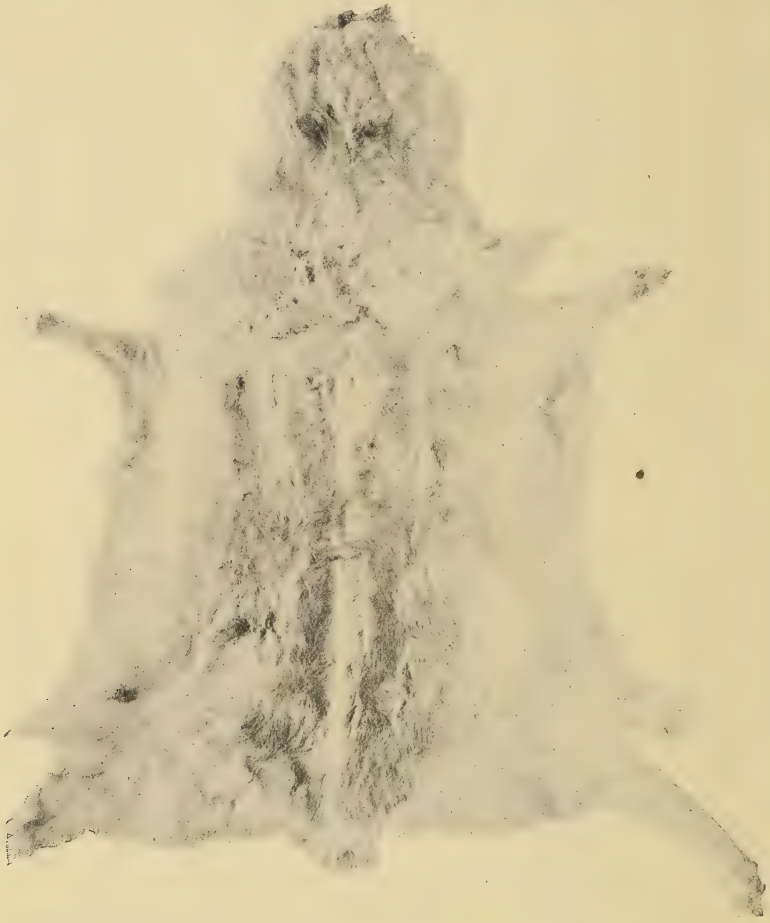


Fig. 1. *Rangifer pearyi*, male (type). No. 19231, Ellesmere Land, June 15. Almost wholly white.

the antlers form knobs an inch or two in height, covered with short hair.

A fawn (No. 19235), a few weeks old, is grayish white on the head, ears, neck, limbs, ventral surface and sides of the body, the hairs being dusky basally and broadly tipped with white, the dusky basal portion

showing through the white enough to give a general dingy effect. The top of the nose and a narrow band bordering the nostrils are blackish, passing posteriorly on the upper part of the rostrum into brownish dusky; a broad central band from the nose nearly to the ears is darker

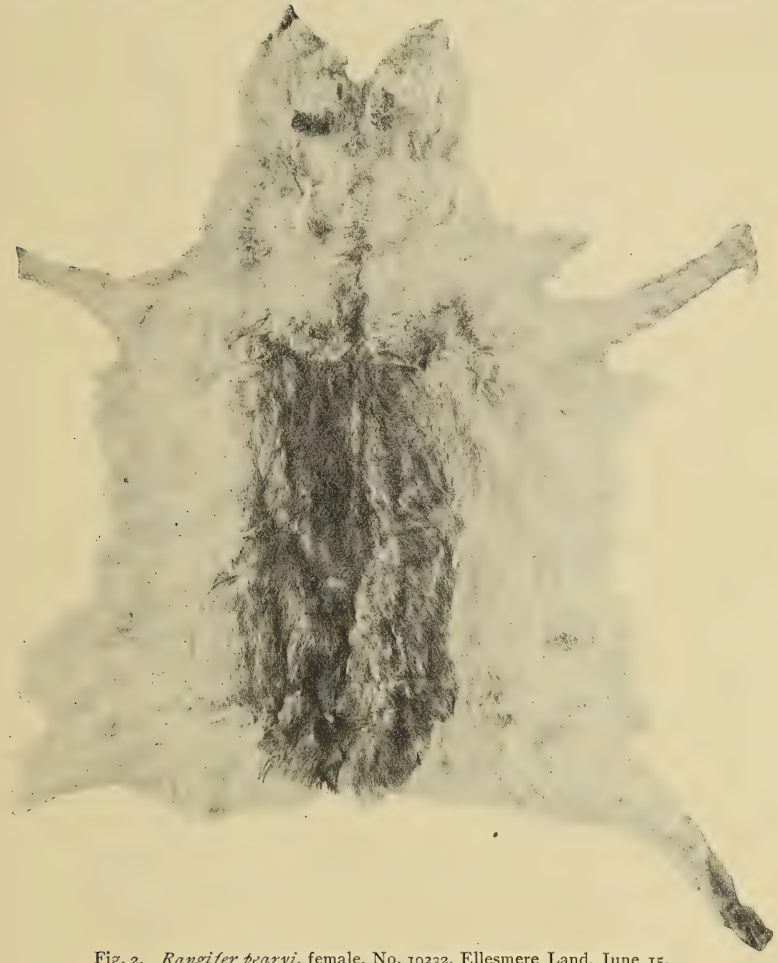


Fig. 2. *Rangifer pearyi*, female, No. 19232, Ellesmere Land, June 15. White except the back, which is drab-gray.

or more dingy than the sides of the face; a rusty brownish spot marks the point where the antlers are to appear, and there is a faint rusty wash on the sides of the face both before and behind the rusty antler spots. The back is marked by a strongly defined, very narrow, ferrugineous line, running from the nape to the base of the tail, which, over

the middle of the back, broadens a little and darkens to deep dusky ferrugineous; the whole dorsal area, from a little behind the shoulders to the rump, is pale fawn color, darkest medially and fading out on the sides to pale buffy white. This colored area corresponds in position and outline with the dark dorsal patch of the adults. A narrow, ill-defined, dusky chestnut brown band borders the hoofs of all the feet, but is rather broader and more distinct on the hind feet than on the fore feet. The tail is wholly white to the base, as in the adults.

The adult specimens, though killed in June, are in winter coat, the hair being long, thick, and very soft, much softer and finer than in the Greenland Caribou, and the skins are also much thinner and softer. The skin of the fawn was preserved in brine, which may have slightly intensified or darkened the buffy shades of the dorsal surface.

Rangifer pearyi is evidently a very distinct insular form, very different from *R. grœnlandicus* in coloration and doubtless in other features. Unfortunately only flat skins are available for examination. Specimens of *R. grœnlandicus* in corresponding pelage are dark slaty brown above, this color fading gradually on the sides to the white of the ventral surface, the Greenland Caribou being very much darker in its winter pelage than the Newfoundland Caribou, which heretofore has been the whitest known form of the group.

I am indebted to Commander Peary for the following information regarding the occurrence of Caribou in Ellesmere Land. In a letter dated Philadelphia, October 13, 1902, he says: "In answer to your inquiries I will say that remains and traces of reindeer have been noted by previous explorers at the following points in Ellesmere Land and Grinnell Land: Alexandra Haven, Ellesmere Land; Rawlings Bay, Grinnell Land, and in the Fort Conger region, Grinnell Land; and an antler was picked up by a member of my party in the summer of 1901 at Erik Harbor, some twelve miles south of Cape Sabine. The published reports of Sverdrup's expedition state that he found reindeer in abundance on the west side of Ellesmere Land.

"I have seen many winter coats of the Greenland Caribou and they are pronouncedly darker than the Ellesmere specimens."

Article XXXIII.—DESCRIPTIVE CATALOGUE OF THE NOCTUIDÆ FOUND WITHIN FIFTY MILES OF NEW YORK CITY. PART II.[1]

By William Beutenmüller.

Plates LVI–LIX.

Trachea delicata (*Gr.*).

Plate LVI, Fig. 1.

Fore wings dark purplish brown-black, with a slight mossy green shading at the base, on the ordinary spots, and along the subterminal line. Transverse lines faint, geminate; posterior line scolloped; anterior line angulate. Orbicular moderate, mossy green, black-ringed, very near the transverse anterior line. Claviform unusually large, prominent, distinctly black-edged, extending across the median field to the transverse posterior line. A paler wide shade extends obliquely beyond these two spots across the median field. Reniform indistinctly outlined, moderate, shaded with black and mossy green, the median shade line visible running obliquely within it over the costal region. Three indistinct white dots on the costa ante-apically. Subterminal line with a rounded inward sinus above the hind angle, and minute projected denticulations opposite the cell, narrowly whitish, preceded by black points and shade marks. Hind wings pale fuscous, with a faint line and discal mark and a much darker subterminal shade. Head and thorax concolorous with the fore wing.

Quite rare in this vicinity. Found during August and September. The markings on the fore wings are not very distinctly marked or contrasting.

Oligia chalcedonia *Hüb.*

Fore wings smoky purplish, costal and basal region more reddish and paler than the rest of the wing. Transverse lines geminate; anterior line upright, angulate; posterior line bent over the reniform, then slightly deflected inwardly in the middle. This line is followed by a whitish shade. A pale subtriangular apical patch. Subterminal line pale, wavy, broken. Orbicular pale, contiguous with the anterior line, center somewhat darker. Reniform small, upright, with a black mark before and behind it. Claviform pale, black-ringed. Hind wings white, slightly smoky outwardly, especially at the apex. Head and thorax gray-brown. Collar reddish. Expanse, 22–26 mm.

[1] For Part I, see Vol. XIV, 1901, pp. 229–312. For explanation of terms used see figure on p. 230 of Part I.

A common species in this neighborhood. The moth is on the wing in May, June, July, and August.

Oligia festivoides (*Guen.*).

PLATE LVI, FIG. 2.

Fore wings reddish brown, the basal and costal region pale grayish white. Transverse anterior line upright, wavy, geminate, more or less obliterated by the gray basal color, but sometimes quite distinct. Transverse posterior line geminate, bent over the reniform on the costa, then straight to the inner margin. Claviform small, pale, dark-ringed, rarely complete, often entirely obscured. Reniform large, oblique, deeply indented outwardly, the upper part usually merged into the pale costal area. Between this mark and the transverse posterior line is a black spot and usually a similar one in front of it. Orbicular small, usually obliterated by the pale shade. A somewhat yellowish apical patch, preceded by a dark patch on the costa. Subterminal line pale, irregularly broken. Hind wings pale, whitish, smoky outwardly. Head and collar dark brown. Thorax gray. Expanse, 22–26 mm.

A small species, readily known by the gray thorax, brown collar, pale costal and basal region of the fore wings, and oblique reniform spot. Rather common in April and May, and again in June and August.

Oligia versicolor *Gr.*

PLATE LVI, FIG. 3.

Fore wings yellowish brown, clouded with dusky. Costal and basal area not paler as in the two preceding species. Veins marked with black and white. Basal line evident, black, anterior line curved between the veins, black. Posterior line black, marked with white, bent around the reniform. Orbicular concolorous with the ground color. Reniform rather large, not very distinct, preceded by a black mark and followed by a yellowish spot touching the posterior line. Claviform not evident. Hind wings pale fuscous. Head and thorax concolorous with the fore wing. Expanse, 22–25 mm.

Recorded from New York and undoubtedly found in this vicinity.

Oligia grata (*Hüb.*).

PLATE LVI, FIG. 4.

Fore wings brown, faintly powdered with gray, and with blackish scales on the veins. Basal line scarcely traceable, pale. Transverse

anterior line narrow, whitish, with a few dark scales at each side, evenly oblique outwardly, or slightly curved. Transverse posterior line narrow, white, sinuate, slightly curved over the reniform and slightly curved inward below. Orbicular very small, punctiform, consisting of a dusky dot, narrowly ringed with whitish. Reniform narrow, ringed with white, strongly constricted in the middle, the upper and lower parts dusky. Subterminal line a little paler, indefinite, and irregular. Terminal space somewhat paler than the ground color. Hind wings light fuscous, whitish in the male. Expanse, 20–25 mm.

This species is not common. It is on the wing from May to October. Probably double brooded.

Perigea xanthioides *Guen.*

Plate LVI, Fig. 5.

Fore wings yellow, more or less clouded with rusty brown, fringes fuscous. Transverse posterior line almost parallel with the outer margin, geminate, usually composed of two rows of black dots. Subterminal line wavy, ill defined on the usually dark outer part of the wing. Orbicular yellow with a rusty center. Reniform yellow, large, somewhat constricted in the middle, with a few dusky dots. Hind wings fuscous tinged with reddish outwardly. Head and thorax rusty yellow. Underside of wings tinged with reddish. Expanse, 22–25 mm.

Caterpillar. — Head small, black, with narrow white stripes in front, meeting on the crown and then joining a clear white dorsal stripe. Body somewhat flesh-colored, covered with brown or black irrorations, and faint flesh-colored lines along the lateral region. Anterior segments with a dark shade produced triangularly behind. Tenth segment raised into a hump. Length, 42 mm.

Food-plants. — Iron-weed (*Vernonia noveboracensis*) and trumpet-weed (*Eupatorium purpureum*).

A common species, but never found in abundance. The moth is on the wing from June to October. It is double brooded. The larva lives on the underside of the leaves on the lower parts of the plant. Enters the ground to pupate.

Perigea claufacta (*Walk.*).

Plate LVI, Fig. 6.

Fore wings clay-brown, outer parts somewhat paler. Veins marked with a little black. Markings indistinct, broken, darker, usually in form of dusky points. Transverse lines geminate. Posterior line followed by a row of small black dots. Subterminal line dusky. Orbicular rounded, not distinct, dark-ringed. Reniform with a few whitish

scales. Head and thorax clay-brown. Hind wings smoky outwardly, paler basally with an opalescent luster. Expanse, 28–36 mm.

A rather common species, found from August to October.

Perigea epopea (*Cram.*).

Plate LVI, Fig. 7.

Fore wings similar to those of *P. vecors*, but more or less heavily marked with gray on the middle lower part of basal space, and with a patch on the outer part of the wing below the apex, and above the hind angle. Thorax gray, collar, and head brown. Expanse, 30–40 mm.

Not rare in this vicinity, from June until October.

Perigea vecors *Guen.*

Plate LVI, Fig. 8.

Fore wings with a silky luster, smoky brown, varying to almost black. Markings rather indistinct in dark specimens. Transverse anterior line geminate, wavy. Transverse posterior line geminate, crenulate, with outwardly a row of minute white points. Subterminal line irregular, yellowish. A series of minute white dots on the costa and outer margin. Claviform black. Orbicular small, round, indistinct, sometimes marked with pale tint. Reniform large, lower part sometimes pale-ringed and with white scales. Hind wings smoky, paler towards the base; fringes whitish or testaceous. Head and thorax concolorous with the fore wings. Expanse, 28–35 mm.

Common all summer from June to October. Possibly a dark form of the preceding species.

Dipterygia scabriuscula (*Linn.*).

Plate LVI, Fig. 9.

Fore wings sooty purplish brown-black. Lines single, deep black. Basal line present, reaching the narrow basal streak. Transverse anterior line dentate, forming a long tooth above the inner margin. Claviform long, black-outlined. Transverse posterior line forming a strong curve around the reniform, then strongly bent inwardly, forming a strong blunt tooth below the middle. Orbicular rounded, black-outlined. Reniform large, black-outlined. Veins on outer part of wing above the middle streaked with black. On outer part below the middle, contiguous to the posterior line, a brown bird-wing-shaped patch streaked with white. This mark sends a pointed dash to the outer margin at the middle of the wing and one to the hind angle.

Fringe dark cut with pale on the veins. Hind wings fuscous; fringes slightly marked with white. Expanse, 30–40 mm.

Caterpillar. — Chestnut brown marked with darker, and with oblique brown dashes. A white line along the dorsum and a dark brown stripe along the sides. Whitish below.

Food-plants. — Sorrel (*Rumex*), plantain, and various other low plants.

The moth is common from May until late in September. The caterpillar enters the earth to pupate.

Hyppa xylinoides (*Guen.*).

Plate LVI, Fig. 10..

Fore wings varying from pale to dark gray, marked with ashen gray, and more or less with reddish about the middle. A broad black basal streak at the middle, and one on the inner margin. Transverse anterior line oblique, strongly waved, marked with white on the indentation below the middle. Transverse posterior line curved outwardly, thence almost oblique below the middle to the inner margin, broadly marked with white. Outer part of wing with black streaks. Subterminal line strongly dentate, with several white teeth to the end of the fringes. The lower part of this line almost touches the posterior line. Apical region usually shaded with pale gray. Orbicular transversely oblong, outlined with gray and black. Reniform large, constricted outwardly, black-outlined. A broad black line from the anterior to the posterior line below the middle. Hind wings dusky, usually somewhat paler basally. Fringes tipped with white. Thorax gray, with a black transverse line anteriorly; tegulæ brown and black-lined. Expanse, 35–42 mm.

Caterpillar. — Head rather small, flat in front, shining black-brown, with a few minute hairs, scarcely visible without a lens. Body above black with a brownish tinge. A broken bluish dorsal line. Below the spiracles a brown stripe, dotted with minute bluish specks appearing like a bloom on the surface. On the second and part of the third segments a short whitish lateral stripe and another on the outer edge of the terminal prolegs. Underside brown, of the same shade as the lateral stripe above, with a similar bloom. Thoracic feet brown. Abdominal legs pale shining brown within, marked with black outside. Length, 32 mm.

Food-plants.—Dandelion (*Taraxacum*), *Chenopodium*, and other low plants.

A very common species. The moth is on the wing from May until late in September. The caterpillar, when ready to

pupate, draws together a few leaves with silken threads, on the surface of the ground or under logs or stones.

Homohadena badistriga (*Gr.*).

Plate LVI, Fig. 11.

Fore wings ashen gray, more or less sprinkled with brown. A broad black basal dash running to the posterior line, and a black line running from the transverse anterior line, above the middle, across the ordinary spots to the subterminal line. Lines black, single. Transverse anterior line curved outwardly. Transverse posterior line strongly outcurved over the cell, then incurved. Orbicular and reniform obscured by the black line. On the outer part of the wing a series of black dashes between the veins. Sometimes the outer parts are much darker than the rest of the wing. Hind wings varying from white to smoky with the base paler. Head and thorax ashen gray to fuscous with a black transverse line behind the collar, extending along the tegulæ. Expanse, 23–32 mm.

Quite rare in this vicinity. The moth is on the wing in June and July. The caterpillar feeds on honeysuckle.

Adita chionanthi (*A. & S.*).

Plate LVI, Fig. 12.

Fore wings gray. Lines single, black. Basal line extending across the wing. Transverse anterior line even, slightly curved outwardly. Transverse posterior line squarely bent around the cell, then abruptly inward and almost straight to the inner margin. Subterminal line not distinct. Veins on outer part streaked with black to the outer margin. Orbicular pale, center dusky, black-ringed. Reniform large, whitish, middle dusky. Hind wings white, margin narrowly lined with black. Head and thorax gray. Collar with a black transverse line. Expanse, 35–40 mm.

Very rare in this neighborhood. The caterpillar feeds on the fringe tree (*Chionanthus*).

Oncocnemis riparia *Morr.*

Plate LVI, Fig. 13.

Fore wings pale ashen brown streaked with white. A short black basal dash and a series of short black streaks between the veins on the subterminal part of the wing. Orbicular transversely elongate. Reniform upright. These spots are obscured by the ground color and are hardly visible. Hind wings dirty white, dusky outwardly. Fringes

white. Head and thorax concolorous with the fore wings. Collar with two transverse brown lines. Expanse, 30–35 mm.

Quite rare in this vicinity. The moth appears in July and August.

Macronoctua onusta *Gr.*

Fore wings with costal region to subterminal space and downward to median vein deep black, other parts leather brown. Transverse lines fine. Anterior line thrice waved, geminate. Posterior line geminate, indistinct above, with deep dentations opposite the cell; the inner part more distinct, curved below vein IV. Terminal space and fringes shaded with blackish. Orbicular inconspicuous on the dark ground color, with a fine velvety black ring. Reniform very large, irregular in shape, faintly outlined above, where it is narrower, with a tendency to display the usual form, but extends inferiorly below the median vein, where it is broader and margined with a distinct velvety black line which reaches the teeth of the posterior line. Claviform small, outlined on the brown lower portion of the median space. Hind wings fuscous shaded with blackish, especially on the costa and terminal space, with a narrow median and terminal line. Head and thorax purplish black. Expanse, 60 mm.

Very rare in this vicinity. The caterpillar bores in the roots of the larger blue flag (*Iris versicolor*).

Dryobota illocata (*Walk.*).

Plate LIX, Fig. 1.

Fore wings broad, fuscous, shaded with reddish basally and on the median space. A very short black basal streak and a transverse basal line. Transverse anterior line dentate at the costal and inner margin, otherwise even and slightly curved outwardly. Transverse posterior line geminate, finely dentate around the cell with a small tooth above the inner margin. The inner part of the line distinct, black, the outer faint. Subterminal line irregular, wavy, pale. At the lower outer part of the posterior line is a rather large whitish patch. The transverse lines are connected below the middle by a black longitudinal line. Orbicular rather large, round, varying from pale to dark brown. Reniform very large, more or less filled with white. A series of small black lunules along the outer margin. Hind wings fuscous, with a narrow, darker line along the outer margin; fringes sometimes tipped with white. Body fuscous; abdomen with tufts along the back. Expanse, 35–40 mm.

Quite rare in this vicinity, but more common northward. It flies in August and September.

Polia contacta (*Walk.*).

Fore wings dark gray; median space somewhat darker than the basal and subterminal spaces. Transverse lines blackish, dentate, and denticulate. No basal dash. Orbicular rounded, small, oblique, dark-ringed. Reniform kidney-shaped, dark-ringed, touched outwardly with whitish, moderate, not quite upright. Subterminal line deeply dentate, dividing the more blackish or fuscous terminal space from the remainder of the gray wing. Subterminal space narrow, widening to the costa, where there are four costal dots. Between veins II and IV it widens, and is cut into large gray teeth by the line. A fine terminal black line. Fringes gray, interlined. Hind wings whitish gray, shaded with fuscous. Head and thorax dark gray. Expanse, 50–52 mm.

A northern species, very rarely met with in this vicinity. Flies in July and August.

Polia medialis *Gr.*

Fore wings vividly marked with white, gray, black, and fuscous. Median space uniform wood-brown or fuscous, shaded with gray on the costa. A black basal dash. Basal and terminal spaces gray, shaded with fuscous. Transverse anterior line black, oblique, dentate. Claviform concolorous with the wood-brown median space, large, reaching to the median shade, narrowly outlined with black. Orbicular large, whitish or gray, oblique, black-ringed. Reniform of the usual shape, large, whitish, nearly straight on the outer side, and connected with the transverse posterior line by black shades along the veins. Transverse posterior line geminate, oblique from its angle on the subcosta; the inner part evident, dentate, black; outer part indistinct. The white fillings of the geminate lines very apparent. Subterminal line white, preceded by black points or streaks at the dentations. Terminal space more shaded with fuscous opposite the cell and at the hind angle. A dentate line cutting the fringes. Hind wings blackish fuscous. Thorax gray; tegulæ shaded with fuscous laterally and with a double line on the collar. Expanse, 40–42 mm.

A northern species, very rarely taken in this neighborhood. It flies in August and September.

Actinotia ramulosa (*Guen.*).

PLATE LIX, FIG. 2.

Fore wings pale ashen gray, streaked with pale brown; dark brown at the middle and outer part. A rather long narrow black basal line. Transverse lines obscured by the ground color. Transverse posterior

line, when present, dentate outwardly on the veins. On the outer part of the wing is a series of dark brown streaks between the veins, and white dentations reaching to the end of the fringes. Orbicular obscured by the pale costal region, broadly elongate, and faintly black-outlined, when present. Reniform large, deeply constricted outwardly, pale gray, more or less filled with brown. The upper part sometimes obscured by the pale ground color. Hind wings pale fuscous, fringes whitish. Expanse, 28–34 mm.

Not uncommon in this vicinity. The moth is on the wing from May to September. Probably double brooded. The caterpillar feeds on *Hypericum perforatum.*

Laphygma frugiperda (*A. & S.*).

Plate LVI, Fig. 14.

Fore wings narrow, mouse gray, variegated with smoky brown, fulvous, and pearly white. Apical patch bluish white. Transverse anterior and posterior lines almost obsolete, or rather well defined, geminate. A short black basal line, the wing below it sometimes light colored. Orbicular large, oblique, elongate oval, usually followed by an oblique light shade. Reniform generally dark, not well defined, the lower part occupied by a short white dash. Subterminal line pale, almost even and parallel with the outer margin, sometimes preceded by black dashes and followed by a series of black dots on the outer margin. Hind wings semi-translucent, white, iridescent, with a narrow, smoky gray outer margin. Head and thorax mouse gray. Expanse, 30–37 mm.

Var. **fulvosa** *Riley.* — Fore wings greatly suffused with fulvous, especially in the lower median space, which often inclines to ochraceous. Oblique median band distinct to median nervure, and the orbicular with an ocher center.

Var. **obscura** *Riley* (Plate LVI, Fig. 15). — Fore wings almost uniform gray with the pale apical patch absent or but faintly indicated. Markings not distinct.

Caterpillar. — Head pale yellowish brown, sometimes tinged with green or pink; the triangular piece yellowish, the inverted V-mark distinct, white, the cheeks with four more or less distinct lateral brown lines and with dark brown reticulations. Body varying from pale brown to dirty green, mixed with more or less pink or yellowish. The markings are produced by fine, more or less intense, brown, crimson and yellow mottling. A narrow line on the back, defined by a darker shade each side of it. A very broad dark line along the subdorsum, the upper edge limited by a yellow line. A buff or flesh-colored line below the spiracles, bordered above by a narrow yellow and wavy line.

Underside pale. Spiracles large, brown, with a pale ring. Legs light or dark. Piliferous tubercles quite large. Length, 28–38 mm.

Food-plants. — Various kinds of grasses and other low plants.

Prodenia commelinæ (*A. & S.*).

Plate LVI, Fig. 16.

Fore wings rather rich wood-brown, variegated; costal region and inner margin ashen brown. An apical grayish patch extending obliquely downwards as a purplish gray-brown shade along the transverse posterior line. Transverse anterior line more or less distinct, curved outwardly. Transverse posterior line oblique, very slightly wavy, geminate, black. A very short, black, up-curved basal streak and a small black spot on the costa at the base. Median vein between the anterior and posterior lines pale ocherous, sending two short branches downwards on the veins. Orbicular narrow, oblique, lower part open, upper part black-ringed, filled with ocherous and brown, followed by a pale dash. Reniform obsolete, broken, with a short light streak or dash outwards, directed obliquely upwards. Subterminal line double, pale. Outer margin with a row of black lunules. Fringes cut with pale ocherous. Hind wings semi-transparent, white, iridescent; slightly dusky at outer margin and costa. Thorax concolorous with fore wings; tegulæ edged with black and wood-brown inwardly. Collar edged with wood-brown. Expanse, 40–50 mm.

Caterpillar. — Head deep shining brown, with the inverted V-mark white. Cervical shield same color as the back. Caudal plate with black spots, between which is a longitudinal cream-colored dash. Body black with a somewhat brownish line along the back, and a dingy shade each side of it. Subdorsal region very dark, with, at its junction with the dorsum, a pale buff line. On the sides and near the middle it is finely sprinkled with a light color. Piliferous spots black, those on the back usually white at the base. Line along the spiracles light buff. Length, 35–40 mm.

Food-plants. — Grasses and various other kinds of low plants.

Not common. The moth appears in July and is on the wing until October. The caterpillar enters the ground to pupate.

Prodenia ornithogalli *Guen.*

Plate LVI, Fig. 17.

Fore wings brown, variegated with ashy brown; veins below the middle, on the median part, lined with whitish to the posterior line, and also at the base. Transverse anterior line geminate, sinuate, not distinct, marked with black. Transverse posterior line irregularly

wavy, geminate, the intervening space more or less whitish as it reaches the inner margin. A bluish white apical patch and another at hind angle, the two connected by a dull bluish white shade, contiguous to the posterior line. Subterminal line whitish, curved outwardly at the middle, and followed by a pale line parallel to outer margin. A terminal row of black lunules and the fringes cut with white. The subterminal line is preceded by black dashes. Orbicular oblong, oblique, lower part open and touching the white line on the vein, ringed with whitish and black, center dusky. Reniform not very distinct, lower part broken by the pale branches of median vein, constricted at the middle outwardly, partly ringed with black and whitish. In the upper part are two white lines, touching the outer pale ring. Hind wings semi-transparent, iridescent, narrowly fuscous in front of the fringes. Head and thorax variegated with white, brown, and black. Expanse, 38–45 mm.

Caterpillar. — Head and cervical shield black. Dorsal line pinkish lilac; the dorsal space contains a series of dark brownish drab spots, the broadest part occupying the centre of each segment, the spots connecting with each other at the junctions of the segments. These spots extend from the dorsal line two thirds of the distance to the subdorsal. On the subdorsum is a series of either triangular or semi-oval velvety black spots, one to each segment on each side of the body; these extend half way to the dorsal line, thus encroaching a little upon the drab spots. Subdorsal line same color as the dorsal, with a narrow bright yellow semi-elliptical spot at the base of each black spot. All the dorsal space not filled with these spots is gray. Substigmatal line white. A line in the middle of the subdorsal space the same color as the dorsal; the space above this intermediate line of about the same color as the line, but irregularly striped finely with black; below the same line the space is black, striped with white. Below stigmatal line, fleshy gray, spotted with white. Length, 32–36 mm.

Food-plants. — Grasses, salsify, wheat, rye, corn, etc.

A common species, but it is not abundant. The moth flies from August until October. The caterpillar enters the ground to pupate.

Prodenia eudiopta *Guen.*

Plate LVI, Fig. 18.

Fore wings brown, variegated, bluish white, middle part more or less pale brown sometimes tinged with reddish. A series of white dots on the costa beyond the middle. Otherwise the markings are similar to *P. ornithogalli*. Thorax pale clay-brown, with slightly darker markings. Expanse, 32–38 mm.

Smaller than *P. ornithogalli* with the fore wings more marbled and the median space usually pale brown.

The moth is on the wing from August until October.

Trigonophora periculosa (*Guen.*).

Plate LVI, Fig. 19.

Fore wings clay-brown. Transverse lines dark, narrow, and broadly geminate. Basal line reaching to a little below the middle. Anterior line slightly outwardly oblique, inner part wavy, the outer almost even. Posterior line rather sharply angulate opposite the cell, thence slightly wavy and inwardly oblique to the inner margin. Subterminal line broad, dark olive brown. The median space filled with olive brown forming an ill-defined V-mark, not reaching the costa, and with a small olive brown, inverted V-shaped mark from the costa pale-outlined. Terminal part of wings darker with a series of dark lunules. Fringes scolloped, tipped with black. Hind wings tinged reddish, costal region testaceous. Thorax concolorous with fore wings and with a ferruginous tuft in the middle. Expanse, 45–50 mm.

Var. **v-brunneum** *Grote* (Plate LVI, Fig. 20). — Like the type form but with a dark velvety brown V-shaped median area.

Sometimes quite common. Found from August until October.

Brotolomia iris (*Guen.*).

Plate LVI, Fig. 21.

Fore wings pale clay-brown, with a prominent V-shaped, olive-green median area. An olive mark on the inner margin before the anterior line, and an olive shade line across the outer part of the wing in front of the subterminal line. Transverse anterior line slightly elbowed below the costa, thence outwardly oblique to the inner margin where it meets the inner part of the posterior line. Subterminal line almost even and parallel with outer margin, pale, dark outwardly. Terminal part of wing pinkish with a row of ferruginous lunules. Outer margin sinuate below the middle. Posterior line inwardly oblique, slightly bent opposite the cell. Orbicular and reniform rather large, pale-outlined, more or less connected at the lower parts by a pink shade. Hind wings pale testaceous, outer part pinkish brown with a pale line. Head and thorax testaceous, the latter with a slightly darker tuft in the middle. Expanse, 38–48 mm.

Not common. Flies in June and July. May be known readily by the pale brown fore wings, with olive-green V-like mark.

Euplexia lucipara (*Linn.*).

Plate LIX, Fig. 4.

Fore wings varying from light to dark brown, somewhat tinged with purplish; median space usually darkest, sometimes followed by a very pale testaceous shade line; terminal space also dark. Anterior line geminate, outwardly oblique, blackish, not very distinct. Basal line black, with a small black mark at the lower outer side. Transverse posterior line slightly curved around the cell, and inwardly below the middle, geminate, brown. Subterminal line subdentate, blackish. Orbicular almost obscured by the ground color, oblique, dark-outlined. Reniform rather large with a more or less light brown central lunule and ringed with pale testaceous. Hind wings dusky outwardly, pale basally. Fringes with a pale brown line at the base. Head and thorax purplish brown. Expanse, 26–32 mm.

Caterpillar. — Head greenish testaceous. Body emerald green with a faint broken dorsal line and a darker shading over the dorsum; junctions of segments yellowish. Lower lateral space pale bluish green. On the top of the eleventh segment, which is somewhat swollen, are two small spots of clear white. Underside wholly bluish green. Length, 35 mm.

Food-plants. — Birch, *Viburnum*, blackberry, raspberry, etc.

Quite common everywhere in this vicinity, from June until September.

Nephelodes minians *Guen.*

Plate LVII, Fig. 1.

Fore wings broad, purplish brown; median space darker rusty brown, with the dark median line running obliquely from the costa, between the spots to the inner margin. Transverse anterior line broadly geminate, curved outwardly, not very distinct, sometimes almost obscured by the ground color. Transverse posterior line curved around the cell, and bent inwardly below the middle. Subterminal line dark, irregularly dentate. Orbicular more or less distinct, usually large, round, sometimes elongate, the upper part touching the costa. Reniform large, kidney-shaped. These spots are paler than the dark median space, but are not contrasting. Hind wings fuscous, fringes roseate. Head and thorax concolorous with fore wings. Expanse, 30–48 mm.

Var. **violans** *Guen.* — Like the type form but with the fore wings more uniform, darker purplish brown.

Caterpillar. — Head large, gray, mottled with brown, and with a brown border to the eyes. Cervical shield very dark brown, crossed by the dorsal and subdorsal lines. Body robust with four broad dark

brown stripes on each side, alternating with three narrow grayish yellow ones, the latter in the dorsal and subdorsal regions, and much lighter at the extremities of the body. Underside yellowish gray. Length, 40 mm.

Food-plants. — Corn, grass, smartweed (*Polygonum*), buckwheat, and other low plants.

A rather common species in this vicinity, found during August and September. The caterpillar is sometimes injurious to garden vegetables. It feeds mostly at night, remaining concealed during the day under rubbish, stones, or dirt.

Tricholita signata (*Walk.*).

Fore wings brown, with ferruginous shades. Transverse lines dark brown, regular and distinct. Anterior line undulate above the median nervure, where it is bent inwardly and thence continues almost straight to the inner margin. Median shade very distinct, broad, not clearly defined along its edges, strongly angulated in the middle and nearly touches the reniform. Transverse posterior lines obliterated on the costa, subparallel, broadly undulating, dentate between the veins in the middle. Orbicular small, ferruginous, ringed with brown. Reniform long and narrow, pure white, crossed by the black veins, its upper half more or less shaded with ferruginous. Veins black, with white specks. Fringes edged with a basal and exterior black line. Hind wings dark fuscous, paler basally, with a black line at base of fringes. Expanse, 34–38 mm.

May be readily known by the white reniform, distinct lines, broad angulated median shade and continuous outer line. It flies during August and September.

Helotropha reniformis (*Gr.*).

Plate LVI, Fig. 22.

Fore wings dark brown, slightly purplish with darker brownish black shades; inner part of subterminal space considerably paler than the rest of the wing. Terminal part black, with bluish white spots composed of scales. A black, obscure, basal streak. Transverse anterior line geminate, more or less distinct, somewhat scolloped, black, space between paler. Transverse posterior line geminate, blackish, space between pale brown, somewhat curved around the cell, with a slight tooth below the costa; at the middle slightly curved inwardly, thence slightly curved outwardly to the inner margin. Subterminal

line usually pale brown, irregular, with two small teeth at the middle, pointing outwardly. A series of small black terminal lunules. Fringes dark. Orbicular like the ground color, pale-ringed. Reniform sometimes pale-outlined, with the outer part white-ringed, a white streak in the middle, and the lower part crossed by the median vein, with the two branches white to the posterior line. Beyond the posterior line the veins are black, marked with a few white scales. Hind wings fuscous, somewhat paler basally. Head and thorax concolorous with fore wings. Collar usually with a black line. Abdomen paler. Expanse, 32–40 mm.

Var. **atra** *Grote* (Plate LVI, Fig. 23). — Fore wings dark purplish brown, with the marking almost obscured by the ground color, except the white reniform, which is ringed or testaceous.

Very common everywhere in this neighborhood, from July until late in September.

Gortyna u-album (*Guen.*).[1]

Fore wings varying from purplish brown to almost carneous, with a richer reddish brown shade through the middle of the median and terminal spaces. At base, along the inner and costal margin, is a distinct bluish shading which varies in intensity in some specimens, sometimes quite strongly relieving the reddish brown disc. Transverse lines narrow, inconspicuous. Orbicular sometimes wanting. Reniform moderate, normal in shape, lower half defined and partly filled by white scales, somewhat U-shaped. Hind wings dark fuscous; fringes roseate. Head and thorax deep purplish brown. Expanse, 28–32 mm.

Recorded from New York, Massachusetts, and Illinois, and undoubtedly found in this vicinity. The earlier stages are unknown.

Gortyna velata (*Walk.*).

Plate LVII, Fig. 2.

Fore wings somewhat purplish red brown, with a slightly darker median shade. Transverse lines not contrasting. Anterior line single, upright, curved between the veins. Posterior line geminate, slightly curved outwardly above the middle, almost even, crenulate, the outer part less distinct. Subterminal line pale, irregular, preceded by a paler shade; terminal space darker. Veins more or less marked with black and white scales. Orbicular oval or round, concolorous, very faintly outlined by white scales. Reniform upright, constricted in the

[1] I am under obligation to Mr. Henry Bird, of Rye, Westchester Co., New York, for the loan of specimens of *Gortyna*, from which the figures on Plate LVIII have been made. For further information regarding the species of *Gortyna*, see Prof. J. B. Smith's revision of the genus (Trans. Am. Ent. Soc., XXVI, pp. 1–48).

middle, lower part dilated, outlined with white scales. Fringes scolloped. Hind wings smoky luteous, fringes paler. Head and thorax concolorous with fore wings. Expanse, 30–37 mm.

Very common everywhere from June until August. The caterpillar is said to feed on anemone.

Gortyna nictitans (*Linn.*).

Plate LVII, Fig. 3.

Fore wings rusty yellow brown, somewhat varying in shade. Markings distinct but not contrasting, the lines a little darker than the ground color. Basal line present. Anterior line broadly geminate, upright, curved outwardly between the veins. Median shade line sharply angulate in the middle. Transverse posterior line geminate, the inner part crenulate, slightly outcurved, bent inwardly a little above the inner margin. Subterminal line irregular, broken at the apex which is a little paler than the rest of the wing. Orbicular small, round, somewhat paler than the ground color, rarely white. Reniform rather large, outer part constricted in the middle, whitish or pale yellowish, with a dark lunule on the inner part. Claviform not distinct. Hind wings smoky, somewhat variable. Fringes paler. Expanse, 30–34 mm.

Var. **erythrostigma** (*Haw.*), Plate LVII, Fig. 4.— Like the type form, but with the orbicular and reniform same as the ground color.

A common species found in July and August. The caterpillar bores in the roots of grasses.

Gortyna immanis (*Guen.*).

Plate LVII, Fig. 5.

Fore wings varying from light to dark yellow brown, with the median space darkest. Transverse lines darker than the ground color, geminate. Transverse anterior line upright, with a slight inward bend near the costa. Transverse posterior line abruptly bent on the costa and then almost evenly oblique inward to the inner margin, the outer part less defined than the inner. Subterminal line geminate, curved outward between the veins, broken near the apex. A terminal narrow line along outer margin at base of the fringes. Median shade fairly well defined, somewhat curved. Orbicular oval, rather large, a little paler than the ground color and faintly outlined. Reniform large, upright, kidney-shaped or constricted in the middle on each side. Claviform indistinctly visible, dark-filled or wanting. Hind wings pale yellowish brown, darker in the female, with a darker median shade line. Expanse, 44–50 mm.

A large species, found during August and September. Not common. The caterpillar bores in the stems of the hop.

Gortyna inquæsita *G. & R.*

PLATE LVIII, FIG. 3.

Fore wings yellow brick red, powdered with rusty red and deeper brown, with the markings faintly defined and the veins marked with dark brown. Transverse lines geminate. Basal line hardly traceable. Anterior line curved outward above the middle, thence inwardly oblique to a little above the inner margin where it is bent outward. Median shade line distinct, narrow, forming a prominent angle at about the middle of the wing. Posterior line dark, broadly bent or curved outwardly. A dark terminal line at base of fringes. Orbicular somewhat oval, a little paler than the ground color, or white. Reniform upright, more or less defined. Claviform very small, usually yellowish, and divided in the middle by a narrow brown line; it is sometimes marked with white. Hind wings yellowish fuscous, with the veins dusky. Head and thorax concolorous with fore wings, sometimes violet, especially on the collar. Expanse, 27–30 mm.

Quite rare and local. Flies in August and September. The caterpillar bores in the roots of the sensitive fern, *Onoclea sensibilis*.

Gortyna speciosissima *G. & R.*

PLATE LVIII, FIG. 5.

Fore wings yellowish brick red, with darker markings. Subterminal space purplish brown, contrasting. Terminal space paler. Transverse lines geminate, fairly well defined. Basal line rusty brown, not running across the wing. Anterior line indistinct, brown, the inner portion most distinct, evenly outcurved to the submedian vein, and then bending outward abruptly to the inner margin. Posterior line brown, the outer portion broader and more purplish, outwardly oblique to near the middle, then bent rather abruptly, and inwardly oblique, to the inner margin. Subterminal line defined by the difference between the subterminal and terminal spaces, showing sharp teeth outwardly on the veins. A narrow terminal line. Median shade line distinct, rather narrow, angulated. Orbicular small, upright, narrow and white. Reniform oblique, very slender, narrow, white. Claviform upright, short and broad. Veins purplish brown. Hind wings very pale yellowish or slightly tinged with purplish, veins darker. Expanse, 40–52 mm.

Quite rare in this vicinity. May be known by its large size, pale color and linear white reniform. The moth is on the wing in August. The earlier stages are unknown.

Gortyna rigida *Gr.*

PLATE LVII, FIG. 7.

Fore wings pale straw yellow, shaded with purplish between the basal and anterior transverse lines to nearly the middle, outer part beyond the posterior line also purplish except at apex straw yellow. Transverse lines brown. Basal line present. Anterior line geminate, rectangular, and bent outwardly from a little above the inner margin. Posterior line almost evenly oblique from a little in front of the apex to the inner margin, leaving a wide median space. Subterminal more or less traceable. Apex yellow. Median shade line with two angles above the middle, lower part oblique to hind margin. Orbicular round or nearly so, like the ground color, brown-ringed. Reniform rather large, constricted on each side in the middle, straw yellow, brown-ringed, sometimes marked with brown. Claviform rounded, brown-ringed. Hind wings pale testaceous, somewhat dusky outwardly. Head and thorax pale straw yellow; collar tinged with purplish. Expanse, 29–32 mm.

Rare in this vicinity. It flies in August and September. Earlier stages not known.

Gortyna harrisii *Gr.*

PLATE LVII, FIG. 12.

Fore wings with median space yellow, heavily powdered with rusty brown. Basal space purplish, except within the line, yellow. Subterminal space purplish. Terminal space paler, brownish; yellow at the apex. Transverse anterior line geminate, angulate, rusty brown, upright, and bent abruptly outward near the inner margin. Transverse posterior line geminate, the inner portion narrower and paler, the outer line dark, bent abruptly on the costa, then almost evenly oblique to the inner margin. Subterminal line dentate on the veins, defined by the contrast between the purplish subterminal and brown terminal spaces. Median shade line brown, bent on the median vein. Orbicular round, usually white, dark-ringed. Reniform upright, constricted on each side at the middle, yellow, with a central brown linear ring, edges brown with from one to seven white or whitish spots. Sometimes the entire reniform is whitish or blackish. Claviform short and broad, usually white and divided by a narrow central line; sometimes it is reduced to a mere dot or is blackish. Veins rusty brown.

Hind wings more or less smoky, shading to yellowish. Head and collar purplish. Thorax purplish shaded with yellow. Expanse, 32–42 mm.

Rare in this vicinity. The moth flies in September. The caterpillar bores in the stems of *Heracleum lanatum*.

Gortyna purpurifascia *G. & R.*

Plate LVIII, Fig. 10.

Fore wings rich orange yellow, overlaid with rusty brown and purplish scales. Spaces between the basal and anterior lines purple. Subterminal space distinctly purple, contrasting. Terminal space paler purplish, with an orange yellow apical patch. Fringes purplish brown. Transverse basal line geminate, extending to the middle of the wing. Transverse anterior line upright, angulate on the median vein and near the inner margin. Transverse posterior line usually single, slightly curved opposite the cell, then evenly oblique to the inner margin, forming a rather broad black band; inner portion, when present, very narrow. Subterminal line indicated by the differences between the color of the subterminal and terminal spaces. A brown line at base of fringes. Fringes purplish brown. Median shade line narrow, somewhat bent at the middle. Orbicular round, white, sometimes tinged with orange, black-ringed. Claviform upright, much broader than long, almost touching the orbicular, white, upper half sometimes filled with orange, usually black-outlined. Reniform upright, somewhat constricted in the middle, rusty orange, with a darker central linear ring, surrounded with one or more white dots. Hind wings ochraceous, somewhat purplish outwardly. Head and thorax purple, the latter orange yellow on the disc. Collar edged with orange yellow. Expanse, 28–36 mm.

Not common. It may be known by the rich orange fore-wings overlaid heavily with rusty brown scales, and the contrasting purple subterminal space. The moth is on the wing in August and September. The caterpillar bores in the roots of wild columbine (*Aquilegia*) and loosestrife (*Lysimachia quadrifolia*).

Gortyna rutila *Guen.*

Plate LVIII, Fig. 4.

Fore wings golden yellow, heavily overlaid with rusty brown scales, giving a rusty appearance. Space between basal and anterior lines purplish brown. Subterminal space purple. Terminal space rusty brown. Apical patch golden yellow. Transverse basal line geminate,

rusty brown. Anterior line upright, angulate, not very distinct. Posterior line geminate, the inner part rusty brown, the outer blackish. This line is curved below the costa, thence almost evenly oblique to the inner margin. Subterminal line yellow, broken. Fringes purplish brown. Orbicular rounded, clear white. Claviform broader than long, divided in the middle by a rusty line, clear white, upper portion partly filled with rusty brown. Reniform golden yellow, with an elongated, central rusty brown ring, surrounded by clear white spots. Median shade line curved at the middle. Hind wings pale purplish brown. Head and thorax purple. Collar edged with yellow. Abdomen purplish. Expanse, about 35 mm.

This species is recorded from New York and is undoubtedly found in this vicinity. The moth flies in September.

Gortyna circumlucens (*Sm.*).

Fore wings evenly yellowish or red brown, the subterminal space scarcely darker than the rest of the wing. A small white spot at the middle of the base. Transverse lines traceable but not contrasting, geminate. Basal line sometimes marked with white. Anterior line, as a rule, white-marked on the costa. Posterior line broadly bent over the cell, well removed outwardly, and inwardly oblique and a little curved to the inner margin. Subterminal line marked by the contrast between the subterminal and terminal space. Apex yellowish. Veins marked with purple. Median shade line narrow, purplish brown, not contrasting, bent below the reniform. Before the apex on the costa are three small white dots and one over the reniform. Spots white, contrasting. Orbicular triangular, brown-outlined. Reniform a little constricted at the middle, lower portion broadest, with a central yellow lunule surrounded by white spots. Claviform double, the upper one smallest. Hind wings varying from yellowish to purplish. Head and thorax shaded with purple, disc yellowish. A white tuft at base of the antennæ. Expanse, 32–40 mm.

Very rare in this vicinity. The earlier stages are not known. It is allied to *G. rutila*, but is a narrower winged species with hardly any contrast between the different portions of the fore wings.

Gortyna appassionata *Harvey.*

Plate LVIII, Fig. 8.

Fore wings with median space yellow, rather heavily scaled with bright rusty red scales, especially between the spots. Space between basal and anterior lines bright rusty red (burnt sienna) with a small

yellowish spot above the middle. Space at extreme base before the basal line yellow. Outer part of wing rich burnt sienna, the subterminal space a trifle darker. Basal half-line geminate, filled with yellow. Anterior line upright, geminate, partly filled with yellow, obscured costally by the dark ground color. Posterior line geminate, distinctly scolloped, inwardly slightly curved around the reniform, then continued evenly to inner margin, filled with yellow. This line almost touches the reniform. Subterminal line indistinct, marked by a few yellow scales. Median shade line distinct below the middle to the inner margin, scolloped. A yellow spot on the costa at the inception of all the transverse lines. Orbicular large, irregularly rounded, with a rusty brown central dot. Claviform very large, composed of two large spots, the upper almost touching the orbicular; white upper portion marked with yellow. Reniform very large and broad, rounded, with a yellow, linear, central lunule, and surrounded with seven rather large white spots. Hind wings reddish, testaceous basally. Head and thorax rich reddish purple, with a small yellowish tuft at the base of the antennæ. Abdomen reddish. Expanse, 32–37 mm.

Very rare in this vicinity. The moth is found on the wing in September. The caterpillar bores in the roots of the pitcher-plant (*Sarracenia purpurea*).

It is a very brilliantly marked species, readily distinguished from all its congener by the bright, uniform, burnt sienna outer part of the fore wings, and very large white spots.

Gortyna marginidens *Guen.*

Plate LVIII, Fig. 2.

Fore wings with median space yellowish brown, paler toward the inner margin. Basal and outer part of wing purplish. Basal line geminate, filled with white, with two yellowish spots between it and the base, and a small one outside the basal line. Anterior line ill-defined, with a little white on the costa and marked with yellow at the inner margin. Posterior line geminate, crenulate, dark, curved around the cell, then bent inwardly at the middle. Subterminal line broken, yellow, with a brown lunule on the inner part, distinctly yellow on the costa. Median shade angulate, dark. Orbicular rather large, white with a brown center. Claviform composed of two rather large white spots, the upper one partly filled with brown. Reniform large, lower part broadest, surrounded with a series of rather large white spots. Before the apex on the costa are four minute white spots and a larger one above the reniform. Hind wings purplish fuscous, tip of fringes whitish. Head and thorax purplish, the latter

somewhat yellow centrally. Collar edged with white. Expanse, about 40 mm.

Quite rare in this vicinity. The moth is found in September and early in October. The caterpillar bores in the stems of the spotted cowbane (*Cicuta maculata*).

Gortyna furcata (*Sm.*).

Fore wings straw yellow varying to reddish luteous, with the markings fairly evident. Basal line geminate, brownish, in darker specimens merged into the ground color leaving the intervening space a little paler. A small white dot a little beyond basal line. Anterior line geminate, brownish, irregular, somewhat inwardly oblique to the submedian vein, below which it curves outwardly to the inner margin. This line is sometimes indistinct. Posterior line geminate, crenulate, evenly curved over the cell, then curved slightly inward. Subterminal line irregular, dentate on the veins. Terminal space somewhat paler, with a brown line, beyond which the fringes are brownish. Median shade somewhat diffuse, angulate at the middle. Orbicular white, irregularly oval. Claviform elongate, white, brown-outlined. Reniform very large, constricted in the middle, lower portion much broader than the upper, with a yellowish central lunule, and surrounded with seven white spots of various sizes. Hind wings yellowish. Head and thorax with a rosy or purplish tinge. Expanse, 31–45 mm.

Rare in this vicinity, and nothing is known of its earlier stages.

Gortyna baptisiæ (*Bird.*).

Plate LVIII, Fig. 9.

Fore wings with median space rich yellow, densely covered with rusty scales; extreme base of wings golden yellow. Subterminal space purple, with two rather strong dentations at the middle. Subterminal space like the median space. A golden yellow apical patch. Basal half-line distinct, geminate, filled with yellow, with a small yellowish white dot beyond. Anterior line geminate, upright, partly obscured by the ground color, angulate. Posterior line curved around the cell, then almost straight to the inner margin. Median shade line angulate, upper part touching the reniform. Subterminal line rather distinct, broken. Orbicular large, white. Claviform composed of two white spots, the upper one smallest. Reniform with a central yellow linear lunule, and surrounded with white spots, one on the outer side yellow. Hind wings testaceous, roseate outwardly. Head and thorax rusty purple, disc deep yellow. Collar edged with yellowish. A small white tuft at base of antennæ. Expanse, about 35 mm.

Allied to *S. marginidens*, but uniformly smaller. The fore-wings are more rusty brown, the base of the wings golden yellow, and the reniform is differently shaped. The collar also lacks the white edge.

Although this species has not yet been found in this vicinity, it has been deemed advisable to include it in the list, for comparison. Its habitat is Providence, Rhode Island. The caterpillar bores in the stems of *Baptisia tinctoria*, a common plant in this vicinity. The moth is on the wing from late in August until about the middle of September.

Gortyna limpida *Guen.*

Plate LVIII, Fig. 7.

Fore wings with space between the anterior and posterior lines rich seal-brown, shaded with reddish near the inner margin. Basal and outer parts deep silky purplish brown. Basal line obscured by the ground color. Anterior line traceable only near the inner margin, geminate. Posterior line geminate, blackish, not contrasting, curved around the cell to the middle, then curved inwardly. Subterminal line a little darker than ground color, outwardly dentate on the veins, and with a few reddish scales below the costa. On the costa in front of the apex are four minute white dots and a larger one above the reniform. Median shade line visible near the inner margin. Orbicular large, rounded, creamy white. Claviform inwardly oblique, much broader than long, creamy white. Reniform large, outwardly oblique, center yellowish with an elongate brown ring, and surrounded with about seven creamy white spots, those on the inner portion largest. Hind wings smoky brown. Head and thorax deep purplish. Collar edged with white. Abdomen smoky brown, somewhat purplish. Expanse, 30–37 mm.

A beautiful species, easily known by the rich, seal-brown median space, the silky, purplish basal and outer spaces, and the contrasting creamy white spots. The caterpillar bores in roots of speedwell (*Veronica virginica*).

Gortyna cerussata *Gr.*

Plate LVII, Fig. 9.

Fore wings broad, rich umber brown in the median space, reddish at the inner margin. Basal and subterminal spaces purplish. Terminal

space purplish umber brown. Transverse lines not well defined. Basal line marked with four whitish spots. A small white spot at extreme base of wing. Anterior line defined by the difference in shade between the basal and median spaces, sometimes slightly filled with yellow. Posterior line geminate, lunate, very dark, curved around the cell, then somewhat incurved. Subterminal line irregular, marked with reddish and yellowish scales. Apical patch not contrasting, reddish. Orbicular rather large, white. Claviform composed of two white spots. Reniform elongate, oblique, with a yellowish narrow linear central lunule and surrounded by about seven white spots. Hind wings dark fuscous. Head and thorax purplish. Collar edged with white. Expanse, 35–50 mm.

A large, showy species, allied to *S. limpida*. It differs from that species by being considerably larger and heavier in build, also by the difference in color of the fore wings, and by having a cluster of small white spots at the basal line and one at the extreme base of the wing. The moth is on the wing in September. The caterpillar bores in the roots of ironweed (*Vernonia noveboracensis*).

Gortyna cataphracta *Gr.*

Plate LVII, Fig. 6.

Fore wings golden yellow, in the median space, extreme base and at the apex, powdered with purplish. Outer part beyond the posterior line, and basal space between the lines, purplish. Transverse lines geminate, distinct, purplish, spaces between golden yellow. Basal line sometimes obscured by the purplish ground color; when present, angulate, and not extending across the wing. Anterior line with two outward angles below the costa, then bent obliquely inward to a little above the inner margin where it is prominently bent outward. Posterior line curved around the cell, bent a little inward at the middle, then almost oblique to the inner margin. Subterminal line more or less distinct or almost absent. Median shade line purplish, angulate in the middle. Orbicular golden yellow with a purplish dot in the center and narrowly ringed with brown. Reniform a little oblique, rather large, golden yellow, constricted on each side in the middle, dark-ringed and with an elongate brown-ringed lunule in the middle touching the upper and lower parts of the spot. Claviform much broader than long, golden yellow, brown-ringed and crossed in the middle by a brown line on the vein. Hind wings smoky brown, crossed by a darker median shade line. Head and thorax purplish. Expanse, 25–40 mm.

A rather common species, but local, like all the other species of *Gortyna*. The caterpillar bores in the stems of the Turk's-cap lily (*Lilium superbum*), wild lily (*L. canadense*), thistle, sunflower (*Helianthus giganteus*), meadow rue (*Thalictrum*), motherwort (*Leonurus*), *Verbena hastata*, lettuce (*Lactuca*), ironweed (*Vernonia noveboracensis*), rhubarb, dahlia, raspberry shoots, etc.[1]

Gortyna duovata (*Bird.*).

PLATE LVIII, FIG. 1.

Fore wings dull golden yellow, heavily scaled with brown. Space between basal and anterior lines and subterminal space somewhat purplish. Terminal similar to the median space but darker. Apical patch yellow. Basal half-line present, geminate, brown. Anterior line present, but not very distinct, upright, angulate. Posterior line distinct, geminate, bent opposite the cell, then even to the inner margin. Orbicular rounded, white or yellowish, with a brown central dot. Claviform much broader than long, divided in the middle by a brown streak, upper portion partly filled with yellow. Reniform with a yellow, linear central lunule, surrounded by about six or seven white or yellowish spots. Median shade line dark, angulate. Hind wings fuscous. Head and thorax purplish, the latter somewhat yellowish on the disc. Expanse, 34–40 mm.

In general appearance this species resembles *G. cataphracta*, but the spots are white instead of uniform yellow. The moth is on the wing in September. The caterpillar bores in salt-marsh goldenrod (*Solidago sempervirens*).

Gortyna impecuniosa *Gr.*

PLATE LVIII, FIG. 6.

Fore wings rusty red-brown, finely scaled with golden yellow. Basal space purplish brown, except at the extreme base. Subterminal space purplish, distinctly dentate on the veins outwardly. Terminal space rusty brown. Apical patch indicated by a few yellow scales. Fringes purplish brown. Transverse basal and anterior lines not distinct. Posterior line parallel with outer margin, slightly crenulate, geminate, the outer portion dark, the inner very narrow and faint. Median shade line dark brown, prominently angled at the middle. Orbicular round, a little paler than ground color, with a central rusty dot; claviform similar, but larger. Reniform somewhat constricted in the

[1] This list of food-plants was kindly furnished by Mr Henry Bird.

middle, paler than ground color, with a rusty central lunule. Hind wings fuscous, somewhat paler basally, with a dusky median shade line and discal spot. Head and thorax purplish. Collar edged with white. Expanse, 30–37 mm.

Quite rare in this vicinity. The caterpillar bores in the root and lower part of the stem of *Aster umbellatus*. The moth is on the wing late in September and early in October.

Gortyna necopina *Gr.*

PLATE LVII, FIG. 8.

Fore wings almost uniform gray brown with fine whitish atoms. Transverse anterior and posterior lines very faintly indicated or wanting. Basal line and ordinary spots wanting. Tips of fringes white. Hind wings paler gray brown, specked with whitish apically. Head and thorax gray brown heavily sprinkled with white. Expanse, 40–50 mm.

A local species, not rare in this neighborhood. It may be known readily by the evenly colored fore wings. In general appearance it resembles *G. nitela*, but is a larger insect. The caterpillar bores in the stems of wild sunflower (*Helianthus* sp.).

Gortyna nebris *Guen.*

PLATE LVII, FIG. 10.

Fore wings wood brown, very finely powdered with yellowish scales; basal and subterminal spaces purplish, more or less contrasting. Basal line nearly always obscured by the ground color. Transverse anterior line not very distinct, sometimes yellowish outcurved between the veins, with a deep inward tooth below the middle, then with a broad outcurve to the inner margin. Transverse posterior line yellowish, slightly curved around the cell, then running almost oblique to the inner margin. Subterminal line yellow, irregular, more or less broken, sometimes indistinct. Orbicular white. Claviform composed of two white spots, varying in size. Reniform rather narrow, yellow in the center surrounded by a number of white spots. Hind wings gray brown. Head and thorax concolorous with the fore wings. Collar tipped with white. Expanse, 27–40 mm.

Var. **nitela** *Guen.*, Plate LVII, Fig. 11. — This form has the orbicular, claviform, and reniform obscured by the ground color, making them indistinctly visible. The transverse line is also in most specimens very indistinct.

One of the most common and generally distributed species of the genus. It is found everywhere in this vicinity. The moth may be taken from September to October. The caterpillar bores in the stems of burdock (*Lappa major*), great ragweed (*Ambrosia trifida*), currant, corn, potato, tomato, aster, and a variety of weeds.

Achatodes zeæ (*Harr.*).

Plate LIX, Fig. 5.

Fore wings maroon with the veins marked with gray. Transverse lines geminate, dark, blackish, more or less distinct, sometimes filled with gray. Posterior line indicated by a double row of small black spots. Median line a little darker than ground color. An apical orange mark and one near the hind angle, but paler and less distinct. Orbicular very small, grayish brown. Reniform larger, brown and gray, not conspicuous. A series of gray brown spots along the outer border. Fringes tipped with brown. Hind wings pale fuscous. Head maroon, vertex orange. Thorax similar, disc orange. Abdomen with a row of orange tufts along the back. Expanse, 22–35 mm.

Very common in this vicinity. The moth flies in August. The caterpillar bores in the stems of elder, corn, etc. It is whitish with black tubercles and head.

Bellura obliqua (*Walk.*).

Plate LVII, Fig. 13.

Fore wings varying from gray brown to brown, or almost roseate, with the terminal space violet gray. Basal space above the median vein pale, varying from almost white to ashen gray, or pinkish in brown specimens. Transverse anterior line not defined or wanting; when traceable it forms a strong outward tooth below the costa, then runs inwardly oblique to the inner margin. Transverse posterior line single, dark, scolloped. Orbicular small, elongate, not upright. Reniform large, obliquely upright, pale-ringed. Sometimes a dusky median shade line present. Hind wings varying from fuscous to pinkish. Head and thorax concolorous with fore wings. Expanse, 35–52 mm.

Caterpillar. — Head subcordate, rugose, chestnut brown, sometimes jet black, shining. Cervical shield rugose, chestnut brown, sometimes black. Body above shining olive brown, with numerous very fine transverse wrinkles, which are hardly visible to the naked eye; posterior

segment much depressed. Spiracles black. Body beneath dirty brownish white, including the abdominal legs, which have a chestnut brown or jet black patch on the outer side of each, and the extremities black. Thoracic feet chestnut brown or jet black. Length, 55 mm.

Food-plant. — Cat-tail (*Typha latifolia*).

Not rare in this vicinity in swampy places where cat-tail grows. The caterpillar bores in the stem of this plant.

Bellura gortynides *Walk.*

Plate LVII, Fig. 14.

Fore wings ocherous, heavily scaled with cinnamon brown, with a dark shade in the middle of the wing. Transverse lines single, darker than the ground color. Basal line with a strong tooth directed outward. Anterior line with a very sharp outward angle, below the costa, then inwardly oblique to the inner margin. Posterior line strongly dentate outwardly on the veins. Subterminal line dark, even, broken by the veins, as is also the blackish terminal line. Orbicular obscured by the dark ground color. Reniform elongate, oblique, filled with brown, incompletely pale-ringed. Hind wings fuscous, fringes paler. Expanse, 35–47 mm.

Rare in this vicinity. The caterpillar feeds in the stems of the cat-tail (*Typha latifolia*).

Bellura melanopyga *Gr.*

Plate LVII, Fig. 15.

Fore wings pale yellow with the orbicular and reniform concolorous; transverse darker. Basal line absent. Anterior line angulate, below the costa, then evenly oblique to the inner margin. Median shade line not distinct, oblique. Posterior line strongly dentate on the veins outwardly. Terminal space shaded with dusky. A dusky mark at the end of the median vein. Hind wings stained with very pale reddish. Head and thorax yellow. Expanse, 40 mm.

Very rare in this vicinity. It is probably a variety of *B. gortynides*. The caterpillar bores in the leaf-stalks of the common white pond lily and yellow pond lily.

Euthisanotia timais (*Cram.*).

Plate LIX, Fig. 3.

Fore wings bright rose color, costal region at base, and median space to a little below the middle, deep velvety black. Outer part of

wing with some black marks and a terminal row of black and orange spots. Fringes smoky black. At base an orange streak, and on the costa three orange spots. Posterior line indicated by a double row of black spots. Orbicular outlined with orange, as is also the black reniform. Hind wings smoky black. Head and thorax with long, woolly hairs, minutely tipped with white. Expanse, about 45 mm.

Caterpillar. — Head rounded, orange brown with a large black patch on the face of each lobe and one over the ocelli. Body velvety black with a broad yellowish white band in the incisures of the segments reaching to the line of the feet, joined below the line of the spiracles to a short second band which begins on the middle of the sides and extends downward to a little below the line of the feet. A small dot anteriorly situated dorsally on segments 3, 4 and 9–13, and sometimes on 7 and 8. Band on segments 2 and 3 somewhat broken. A small dorsal bar in front of the anal plate. On segments 5, 6 and 12 the pale band runs a little further ventrally and they have a supplementary spot. Feet orange brown. Thoracic feet tipped with black. Claspers black. Cervical shield black. Anal plate orange brown, with a black posterior rim. Tubercles obscure, small.

Food-plant. — Lily (*Pancratium rotatum*).

A southern species, found occasionally as far north as New York. The moth varies in color, being more or less marked with rose color and black. In the south the insect is known as the Spanish moth.

Nonagria subflava *Gr.*

Plate LVII, Fig. 16.

Fore wings ochraceous or buff, median vein smeared with black. A single row of distinct black dots on the veins in the place of the transverse posterior line. Veins somewhat paler, with blackish shadings terminally. Hind wings very pale orchraceous. Head and thorax concolorous with the fore wings. Expanse, 34 mm.

Not common. The moth may be known by the plain ochraceous fore wings, dark median vein, and row of black dots. The caterpillar probably bores in the stems of cat-tail (*Typha latifolia*).

Nonagria oblonga *Gr.*

Fore wings pale reddish or yellowish gray with obsolete markings. The fine, dark, linear denticulate transverse posterior line barely discernible. Stigma very vaguely indicated by paler shades. Hind

wings pale, stained with blackish centrally, and with a faint mesial black shade band. Expanse, 35–40 mm.

Quite rare in this vicinity. The caterpillar bores in the stems of the cat-tail (*Typha latifolia*).

Senta defecta *Gr.*

Fore wings dusky yellowish, with dusky intervenular shades; veins finely streaked with blackish terminally. Median vein marked with white. Reniform indicated by white scales on the median vein at the extremity of the cell. Transverse posterior line indicated by black dots. Hind wings pale, with concolorous fringes and a faint curved median and broken terminal line. Head and thorax like the fore wings. Expanse, 25–27 mm.

Rare in this vicinity. Earlier stages not known.

Platysenta videns (*Guen.*).

PLATE LIX, FIG. 6.

Fore wings bright silky brown with the veins finely powdered with black scales. Median vein marked with black. A white spot near the middle of the wing. Transverse posterior line indicated by a row of small black dots. Terminal line and fringes black cut with white. Hind wings sordid white, slightly tinged with dusky. Fringes white. Head and thorax brown, mixed with white. Expanse, 25–34 mm.

Caterpillar. — Head and body varying from green to purplish or brown, the former with a black band on each side; junction of the segments yellow. Subdorsal and lateral lines indistinct. From the head to anal legs, a broad cream-white band on each side, sometimes bordered above with a narrow brown or purplish line. Eleventh segment humped, with an oval yellowish white spot. Length, about 35 mm.

Food-plants.—Euthamia graminifolia, E. caroliniana, Aster, Linaria, and *Solidago.*

The moth is on the wing from June to September. The caterpillar is subject to considerable variation. Double brooded.

Ommatostola lintneri *Gr.*

PLATE LVII, FIG. 17.

Fore wings very pale yellowish testaceous with the veins marked with white scales, interrupted with blackish. A dusky shade along

the median and sub-median veins, and also between the veins terminally. Posterior line indicated by a row of small black dots. Hind wings white, with a faint testaceous tinge. Head and thorax yellowish testaceous. Expanse, 35–40 mm.

This species seems to be rare in this vicinity. It is found late in August and early in September near the sea-coast. It is reported to be very common at Anglesea, New Jersey. The early stages are not known. The caterpillar probably feeds on or in some maritime plant. In general appearance the moth resembles a *Heliophila*.

Heliophila unipuncta (*Haw.*)[1]

PLATE LVII, FIG. 18.

Fore wings reddish fawn varying toward gray, more or less sprinkled with blackish scales and with a white dot at the end of the median vein. Transverse anterior line usually wanting or indicated by small black dots. Posterior line composed of a series of black dots. Orbicular and reniform slightly paler than the ground color, or with a dusky center. A blackish shade from the upper part of the posterior line to the apex. Hind wings smoky brown, shining, somewhat paler basally. Head and thorax like the fore wings. Expanse, 35–47 mm.

Caterpillar. — Dull black, striped longitudinally as follows: a broad line along the back; then a narrow line; then a narrow white line; then a yellowish line; then a narrow subobsolete white line; then a dusky stripe; then a narrow white line; then a yellowish stripe; then a subobsolete white line. Underside obscure green. Length, 35 mm.

Food-plants. — Grasses and all kinds of low plants.

Very common everywhere all summer until frosty weather. It is found from Canada to Florida, west to Texas and the Rocky Mountains, and southward to South America. It is two or three brooded. The caterpillar is known as the army-worm.

Heliophila pseudargyria (*Guen.*).

PLATE LVII, FIG. 19.

Fore wings luteous gray, sometimes tinged with reddish. Transverse anterior line more or less defined, usually broken, and curved

[1] For further information regarding the species of *Heliophila* (*Leucania*) the reader is referred to Prof. John B. Smith's excellent monograph of the genus (Proc. U. S. Nat. Mus., Vol. XXXV, 1902, pp. 159–209, pll. v-vi).

between the veins. Posterior line slightly curved and composed of two rows of black dots, which are sometimes lunulate. A terminal row of small dots present. Orbicular and reniform more or less distinct, paler than ground color; the former is oval and the latter somewhat kidney-shaped. Hind wings smoky brown, fringes paler. Head and thorax concolorous with the fore wings. Expanse, 30–46 mm.

Caterpillar. — General color fleshy brown sprinkled with dark brown. Dorsal, subdorsal, and stigmatal lines distinguished by not being sprinkled with brown. Dorsal space dark brown, composed of dark brown dots finely sprinkled over the surface. There is a slight massing of these brown dots from the posterior parts of the segments, near the dorsal line, forming outwardly an indistinct V. Subdorsal space much like the dorsal, but paler. Substigmatal space with a few dots; a brown patch at the base of the pro legs. Head same color as the body, mottled with brown. Cervical shield dark brown. Piliferous spots small, brown. Length, 35 mm.

Food-plants. — Grasses and other low plants.

Common everywhere in this vicinity from May to September. Double or triple brooded.

Heliophila pallens (*Linn.*).

Plate LVII, Fig. 20.

Fore wings creamy yellow with the veins paler and more or less streaked with luteous between the veins. At the end of the cell is a small black dot. Posterior line reduced to two black dots. Hind wings white or tinged with blackish. Head and thorax creamy yellow. Expanse, 30–35 mm.

Caterpillar. — Shining yellowish or reddish, with a whitish line along the back bordered with dusky, and a yellowish white stripe on the sides bordered with black.

Food-plants. — Grasses and other low plants.

Very common everywhere in this vicinity. The moth is on the wing from April until late in September.

Heliophila albilinea *Hüb.*

Plate LVII, Fig. 21.

Fore wings pale luteous, costal area from the base to the apex gray or streaked with brown. Median vein very pale, whitish, contrasting with a brown shade above it to the outer margin where it forms a long triangular mark. Below the median vein extending to the end of the vein is a similar shade. In the latter is a black basal streak which

sometimes forms a loop at the end near the middle of the wing. Terminal part of wing marked with whitish. Hind wings whitish, or somewhat smoky outwardly. Head and thorax dark testaceous. Expanse, 28–32 mm.

Caterpillar. — Head yellow, with a somewhat triangular mark on each side. A white dorsal line, then a dark brown stripe, then a pale yellow line, then a light brown line shading into yellow over the lower edge, then a dark brown line along the spiracles, then a pale yellowish line, then an indistinct light brown line. Underside pale yellow. Length, 35 mm.

Food-plants. — Grass and other low plants.

Very common everywhere from May to September. The caterpillar enters the ground to pupate. Double brooded.

Heliophila flabilis *Gr.*

Fore wings ocher or straw color shaded with fuscous. The pale longitudinal shades extend along the cell over the interspace between veins 5 and 6 nearly to the margin; a short pale shade on the interspace above and extending nearer to the margin. From the base a wide submesial pale shading extends outwardly to the margin. A black dot marks the reniform at the end of the median vein, and there is a row of dots on the veins, not prominent. Veins distinctly paler. The darkest portion of the wing is along the median vein, and a fine black streak runs along the interspace between veins 4 and 5. Hind wings whitish, vaguely soiled with fuscous outwardly. Thorax concolorous with the fore wings. Collar without lines. Expanse, 33 mm.

Found near the seashore of Long Island in May.

Heliophila insueta (*Guen.*).

Plate LVII, Fig. 24.

Fore wings pale ocherous, heavily shaded between the veins with rusty brown. Costal region whitish with fine black atoms. Veins white. A short blackish basal streak and an oblique row of black dots forming the transverse posterior line. Head and thorax varying from ocherous to reddish brown. Hind wings whitish, fuscous outwardly or almost wholly fuscous. Expanse, 31–36 mm.

A well marked species, known readily by the red brown color on the fore wings, pale costal region, and white veins. The moth is on the wing in June and July.

Heliophila extincta *Guen.*

Fore wings pale creamy yellow, streaked with blackish and silvery gray, tending to faint reddish. Veins narrowly white. A whitish dot marked by black scales at the end of the median vein. A series of black dots forming the transverse posterior line. Hind wings white, semitransparent, with a somewhat yellowish tint. Head with a slight admixture of brown scales in front. Collar with two dark gray transverse lines. Thorax immaculate. Expanse, 33–36 mm.

The moth is on the wing from early in May to late in August. Earlier stages not known.

Heliophila multilinea (*Walk.*).

Fore wings pale creamy ocherous, lined with brown between the veins. Veins white, the median one margined below with dark blackish or brown. A small black dot in the cell at the end of the median vein. Transverse posterior line reduced to two small black dots. Hind wings white with minute black terminal dots. Head immaculate. Thorax with three gray or blackish transverse lines. Disc of thorax and tegulæ speckled with black. Expanse, 31–36 mm.

Common in this vicinity. The moth flies from May to September.

Heliophila commoides (*Guen.*).

PLATE LVII, FIG. 23.

Fore wings dull grayish luteous more or less marked with brown or reddish and streaked with black. A prominent black streak below the broadly white median vein, and a black dot at the branching of the median vein. Veins narrowly white. Costal region a little paler. A faint black streak a little above the inner margin near the base, and another in the submedian interspace towards the hind angle. There are other black streaks between the veins on the outer part of the wing. Transverse posterior line composed of a row of small black dots. A terminal row of small black dots. Hind wings fuscous, fringes pale dirty white. Head somewhat rusty brown. Collar with three leaden gray transverse lines. Thorax powdered with black. Expanse, 35–40 mm.

Common but not abundant in this neighborhood. The moth is on the wing from June to September.

Heliophila phragmatidicola (*Guen.*).

PLATE LVII, FIG. 22.

Fore wings pale luteous, sometimes reddish, more or less indistinctly strigate. Median vein white, bordered above and below with black-

ish. A minute black dot at the end. A vague blackish shade on the outer part of the wing above vein IV, extending to the apex. A series of minute dots in place of the posterior transverse line. Hind wings white with a very narrow blackish outer border. Expanse, 32–40 mm.

Caterpillar.— A narrow dorsal line, then a wide dark stripe on which is a row of black dots, or in place of this stripe, there is a dark, then a light, then a dark line; next to this is a pinkish stripe, lightest in the middle; then a light line, which is sometimes wanting; then a dark or black stripe, lightest in the middle; then a light stigmatal line, then a pinkish stripe, which is sometimes wanting; venter dark colored; head pale brownish, with two black dashes on each side, and two curved black lines on the face. Length, 38 mm.

Food-plants. — Grass and other low plants.

Very common everywhere from May to September. Double brooded.

Scolecocampa liburna (*Geyer*).

Plate LIX, Fig. 7.

Fore wings broad, pale grayish brown, sometimes tinged with reddish. Transverse lines reddish, not prominent. Anterior line angulate. Posterior line very broadly geminate, outer portion scolloped, inner portion punctiform. A terminal row of black dots, preceded by a blackish shade above the middle. Fringes broadly cut with black. At base of wing is a small black dot and one outside of the anterior line. Reniform distinct, reddish, black-ringed. Hind wings fuscous, with a terminal row of black dots. Fringes paler. Thorax gray-brown with a black stripe along the middle. Expanse about 40 mm.

Caterpillar. — Head and second segment pitchy black, very lustrous. Body dull grayish white or dull smoky, semitransparent. On each side are ten small brown tubercles, each bearing one or more fuscous hairs. Last segment pitchy black. Length, 45 mm.

Food-plants. — Found in decaying stumps of cherry, hickory, chestnut, oak, etc.

Rather common in woods in June and July. The caterpillar spins a tough cocoon of pieces of wood, intermingled with its own frass.

Ufeus satyricus *Gr.*

Fore wings wood-brown, unicolorous, with a faint trace of an irregular, diffuse, darker-shaded transverse anterior line. An undefined blackish mark in place of the reniform. Transverse posterior line somewhat more distinct than the anterior, parallel with the outer

margin. A series of blackish terminal streaks. Hind wings pale, dirty testaceous. Expanse, 45 mm.

Very rare in this vicinity. The moth is on the wing in July.

Ufeus plicatus *Gr.*

Fore wings uniform warm brown, faintly tinged with reddish. Transverse anterior line broken. Along the cell above the median vein is an interrupted black streak. Transverse posterior line black, comparatively distinct, running outwardly and downwardly oblique from the costa; much curved around the cell. A series of intervenular lunules and a series of fainter blackish terminal lunules. Hind wings dull testaceous. Expanse, 40 mm.

Allied to *Ufeus satyricus*, but differs from that species by having the transverse posterior line much rounded opposite the cell. Very rare in this vicinity. Prof. Smith has recorded it from Newark, New Jersey.

Eucalyptera bipuncta *Morr.*

Fore wings pale testaceous, powdered with blackish scales. Transverse anterior line wanting. Posterior line prominent, blackish, evenly curved around the cell, then evenly oblique to the inner margin. Subterminal line wanting. Orbicular and reniform each replaced by a small black spot. Hind wings pale testaceous. Expanse, 20 mm.

Not common in this vicinity. The moth is found on salt marshes in July.

Doryodes bistrialis (*Geyer*).

Plate LIX, Fig. 8.

Fore wings pale testaceous, with all the margins somewhat darker. From the base to near the apex, along the middle of the wing, is a broad brown band, bordered with white above and below at the outer part. Hind wings pale testaceous. Expanse, 30 mm.

Common on salt marshes from June to September. Probably double brooded.

Phiprosopus callitrichoides *Gr.*

Plate LIX, Fig. 9.

Fore wings varying from ocherous to dark brown, more or less covered with whitish atoms. Transverse anterior line very narrow,

inwardly oblique, bent at the costa. Posterior line inwardly oblique, very strongly angulate below the costa, the outer part of this line running to the apex. Subterminal composed of a series of black lunules. Reniform vague, usually composed of two black marks. A very narrow whitish terminal line. Hind wings very pale ocherous, outer part narrowly fuscous, sometimes with a narrow terminal line. Expanse, 25–30 mm.

Not common. Flies in August. The caterpillar feeds on catbriar, and spins a cocoon on the stems of this plant. The cocoon is covered with long pieces of small twigs, giving the appearance of the sac of a caddisfly larva.

Amolita fessa *Gr.*

Plate LIX, Fig. 10.

Fore wings pale ocherous more or less suffused with reddish brown. From the middle of the base to the apex is an oblique smoky or reddish band, and another from the outer margin below the apex, extending obliquely to the inner margin near the middle of the wing. Orbicular and reniform each composed of a very minute black dot. A row of terminal black dots. Hind wings whitish. Expanse, 24–27 mm.

Not common in this vicinity. It flies from June to September.

Balsa malana (*Fitch*).

Plate LIX, Fig. 11.

Fore wings gray with black transverse lines, all strongly toothed. At the middle of the wing to about the middle of the posterior line is an oblique line, which forms a small V on the costa. Hind wings varying from light to dark gray. Head and thorax gray, the former with a transverse black line in front and the latter with a black Λ in front. Collar edged with black. Expanse, 22–28 mm.

Caterpillar. — Green dotted with yellow. Length, 14 mm.

Food-plant. — Apple.

A common species in this neighborhood. Found from May to August. Double brooded.

Balsa tristrigella (*Walk.*).

Plate LIX, Fig. 12.

Fore wings gray, veins marked with black; transverse line very strongly toothed, giving a streaked appearance. Outer part marked

with brown between the veins. Head and thorax gray, the latter with a broad brown black edge. Hind wings dirty white. Expanse, 20–24 mm.

Allied to *B. malana*, but considerably smaller, with the transverse lines less distinct and the veins marked with black. Found from May to August. Double brooded.

Balsa labecula (*Gr.*).

Plate LIX, Fig. 13.

Fore wings pale gray. Orbicular yellowish white, and the disc beyond it and the place of the reniform are shaded with this same color. Anterior line rounded and not toothed as in its allies. Median shade, crossing the wing obliquely, over the yellowish white shading. Posterior line curved around the cell, slightly dentate. Head and thorax gray, collar edged with black. Hind wings pale fuscous. Expanse, 22–24 mm.

This species in general appearance looks very much like *Apatela retardata*. Very rare.

Catabena lineolata *Walk.*

Plate LIX, Fig. 14.

Fore wings pale fuscous, lines marked with black, scaled with white and with white streaks between the veins. Outer part of wing darkest. Hind wings white, outer part fuscous. Fringes white. Head and thorax whitish, slightly mixed with brown. Collar with two faint brown lines. Expanse, about 28 mm.

Caterpillar. — Head green, striped vertically with brown and white. Body deep green with about ten wavy white lines. Below the spiracles is a whitish stripe. Underside green with four lines, the two in the middle widest. The two anterior pairs of abdominal legs much shorter than the two other pairs. Length, 30 mm.

Food-plant. — *Verbena hastata.*

A rather common species, found from May to August. The caterpillar enters the ground to pupate.

Crambodes talidiformis *Guen.*

Plate LIX, Fig. 15.

Fore wings pale testaceous tinged with darker brown and streaked with black. Costal region marked with black. Transverse posterior

line much broken, dentate. Reniform narrow, elongate, not prominent, ringed with black; below this spot is a rather large blackish patch. A terminal row of small black dots. Fringes broadly cut with black. Hind wings whitish, somewhat tinged with yellowish. Expanse, about 25 mm.

Caterpillar. — Head green with a few dark streaks on the top. Body green dotted with white. A white dorsal and two subdorsal lines. A pink stigmatal stripe and a line on the subdorsal space. Length, 30 mm.

Food-plant. — *Verbena hastata.*

Found from May to September. The caterpillar spins a cocoon, mixed with earth, on the ground.

Caradrina miranda *Gr.*

Plate LVI, Fig. 24.

Fore wings uniform shining brown. Hind wings shining soiled white. Head and thorax brown, shining. Expanse, 25 mm.

Not common. Found from June to September.

Caradrina multifera *Walk.*

Plate LVI, Fig. 25.

Fore wings ashen gray, shining, with blackish transverse lines. Basal half line black, anterior line outwardly oblique, wavy. Median shade angulate at the middle. Posterior line finely dentate. Subterminal line composed of a series of dark lunules. A terminal row of black dots. Orbicular very small, round. Reniform large, partly outlined with black and with a small brown central dot. Hind wings grayish, fringes whitish. Head and thorax uniform gray. Expanse, 30 mm.

Not common. Found during July and August.

Caradrina meralis *Morr.*

Fore wings gray with all the markings quite faint, except the reniform, which is black. Anterior line oblique. Posterior line rounded. Orbicular reduced to a small black dot. Reniform luniform. Hind wings white, slightly grayish terminally. Head and thorax gray. Expanse, 31 mm.

Recorded by Prof. John B. Smith from the northern and eastern States, and certainly is found in this vicinity.

Caradrina derosa *Morr.*

Fore wings dark gray, with the marking black and not distinct. Basal half line present. Anterior line geminate, lobate, and interrupted. Median shade line running between the spots, where it is thickened, forming a black spot. A series of light and dark dots on the costa. Subterminal line faint, preceded below the costa by several conspicuous, partially united, black cuneiform markings. A series of black dots at the base of the fringes. Hind wings white with a broad, diffuse blackish border. Head and thorax dark gray; collar with an interrupted black line. Expanse, 33 mm.

Recorded from New Jersey.

Pyrophila tragopoginis (*Linn.*).

Plate LIX, Fig. 16.

Fore wings uniform shining brown, with indications of a subterminal, broken, transverse shade. Orbicular small, black. Reniform composed of two black spots more or less connected. Hind wings brownish, slightly paler basally. Head and thorax brown. Expanse, 28–32 mm.

Caterpillar. — Head pale apple green, with a dark spot on each side in front. Dorsal, subdorsal, and spiracular lines narrow, pure white. The spiracular line begins on the second and the others on the third segment. On all the segments except the head and second, there are a few minute white granulations tipped with black, and each with a fine hair. Spiracles white. Feet green. Length, 35–45 mm.

Food-plants. — Spinach, *Rumex,* salsify, and other allied plants.

Not common. Found during July and August.

Pyrophila pyramidoides (*Guen.*).

Plate LIX, Fig. 17.

Fore wings shining brown, somewhat purplish. Transverse lines geminate. Basal half line present. Anterior line somewhat oblique, dentate. Median shade line somewhat distinct. Posterior line irregularly bent at the middle, filled with lighter brown. Subterminal line light brown, irregular, sending inwardly a few black dashes. A terminal row of pale brown lunules. Hind wings shining coppery brown, smoky apically. Expanse, 40–50 mm.

Caterpillar. — Head smooth green. Body green, dotted with white or yellow. A white dorsal and subdorsal line, the latter forming an

acute angle on the eleventh segment, which is humped. A yellow stigmatal line. Length, 35 mm.

Food-plants. — Apple, cherry, hickory, oak, lilac, witch-hazel, walnut, willow, poplar, chestnut, etc.

Very common everywhere. The moth may be known readily by the coppery brown hind wings. It flies from May to September. The caterpillar spins a cocoon on the ground.

Anorthodes prima *Smith.*

Fore wings soft, uniform mouse gray. Transverse lines evident, single, blackish. Basal line nearly straight. Anterior line with a strong inward angle on the cell, irregularly oblique below. Posterior line outcurved over the cell, somewhat incurved below, even or slightly crenulate. Subterminal line irregular, yellowish, closely parallel to the outer margin. Median shade line vague, angulate. Orbicular punctiform, blackish. Reniform indefinite, sometimes indistinct, marked with a few white scales. A faint yellowish terminal line. Hind wings smoky gray, shining. Head and thorax concolorous. Expanse, 28–30 mm.

Not common. Found early in spring and again late in the fall.

Orthodes cynica *Guen.*

Plate LIX, Fig. 18.

Fore wings brown tinged with reddish. Transverse lines geminate, distinct, but not contrasting. Anterior line outwardly oblique, slightly wavy, outer portion blackish. Posterior line slightly curved outwardly around the cell, then slightly bent inwardly, inner portion black. Subterminal line pale reddish. Orbicular and reniform like the ground color, faintly outlined by white scales. Hind wings fuscous. Head and thorax like fore wings. Expanse, 28–30 mm.

A common species, found from May to September.

Orthodes crenulata (*Butler*).

Plate LIX, Fig. 19.

Fore wings brown, with fine black atoms. Transverse lines narrow, distinct, pale testaceous, marked with blackish. Basal half line straight. Anterior line oblique, slightly angulate at the costa. Posterior line bent opposite the cell, then straight to the inner margin,

with a few black dots on the outside. Subterminal line straight. Terminal line lunulate. Orbicular and reniform rather large, like the ground color, with testaceous outlines. Median shade line blackish. Hind wings fuscous. Head and thorax like the fore wings. Expanse, about 32 mm.

Rather common. Found from June to September.

Orthodes vecors *Guen.*

Fore wings silky reddish brown, the male smaller and brighter in color. Transverse lines geminate, more or less distinct. Orbicular not evident. Reniform whitish, small. Hind wings fuscous. Head and thorax concolorous. Anal tuft of male ocherous. Expanse, 28–30 mm.

A rather common and variable species. Found from May to August.

Orthodes calceolaria *Strk.*

Fore wings dark smoky shining brown with a somewhat reddish tint. Basal half line composed of hoary scales. Transverse anterior line also grayish white, crossing the wing in a nearly straight line to the inner margin. Transverse posterior line curved outwardly, and not as distinct as the anterior line. Median shade line fuscous slightly darker than the ground color. A dark fuscous subterminal line, the space exterior to this slightly paler than the rest of the wing. Fringes concolorous. The transverse lines are composed of hoary scales, distinct but not sharply defined. Hind wings light fuscous with paler fringes. Head and thorax dark smoky fuscous. Expanse, 30 mm.

Taken on Long Island by Mr. E. Shoemaker, in May and June.

Himella contrahens (*Walk.*).

Fore wings pale testaceous, thickly overlaid with smoky scales, palest along inner margin. Transverse lines geminate, black, filled with pale testaceous. Basal half line present. Anterior line oblique, dentate. Posterior line curved around the cell, then slightly bent inwardly. Subterminal line obscured by the ground color, except as a pale apical streak. A series of pale dots on costa before the apex. Orbicular not evident. Reniform very indistinct, followed by a pale mark. Hind wings dirty whitish, smoky outwardly, and with a median shade line. Head and thorax concolorous. Expanse, 28–30 mm.

Rare in this vicinity. Flies in June and July.

Himella intractata (*Morr.*).

Fore wings uniform soft warm grayish fuscous. Basal half line indicated by black dots. Median line pale, even, shaded with blackish below the median vein. Posterior line a little waved or uneven, pale, with a narrow preceding ocher brown shade line. Ordinary spots very large, a little paler than the median space, rounded, very finely pale-ringed; reniform not excavate. A very fine pale terminal line. Hind wings fuscous, whitish at base, fringes whitish. Expanse, 30–32 mm.

Very rare in this vicinity. The moth flies from April to August. Probably two brooded.

Crocigrapha normani (*Gr.*).

Plate LIX, Fig. 20.

Fore wings reddish brown suffused with gray and with black atoms. Transverse line narrow, distinct, but not prominent. Basal line curved. Anterior line outwardly oblique, even. Posterior line curved around the cell, where it is dentate, then curved inwardly. Subterminal line ill defined. Terminal region grayish. Orbicular like the ground color. Reniform pale-ringed, lower part filled with black. Hind wings whitish, fuscous outwardly. Expanse, about 40 mm.

Not rare in this vicinity. The moth flies from April to June.

Tæniocampa furfurata (*Gr.*).

Fore wings ochery fuscous. Transverse lines geminate, not very distinct, blackish. Ordinary spots small, inconspicuous, obsoletely outlined, the reniform darker, stained with blackish inferiorly. Posterior line denticulate, broken up into black points on the veins. Subterminal line pale, preceded by an inconspicuous series of darker points. A series of black terminal dots. Hind wings whitish fuscous. Expanse, 24–26 mm.

Quite rare in this vicinity. Flies from May to August.

Tæniocampa culea (*Guen.*).

Fore wings gray, overlaid with blackish atoms. Costa distinctly edged with carneous. Only the anterior and posterior lines are distinct, blackish, accompanied by pale, even, conspicuous shades. The former is oblique, the latter rounded and parallel with the outer margin. Ordinary spots distinct, filled with black, and pale-ringed.

Orbicular small and round. Reniform narrow, upright. Subterminal line light, faint, containing a series of interrupted blackish dots. Fringes concolorous, with a yellow line at the base. Hind wings fuscous with a discal dot; base of fringe with a yellow line, separated from the outer whitish portion by a dark line. Expanse, 35 mm.

Found from May to July.

Tæniocampa oviduca *Guen*

Plate LIX, Fig. 21.

Fore wings brown, sometimes reddish, markings distinct but not contrasting, slightly paler than the ground color. Basal line evident. Anterior line geminate, slightly curved inwardly near the costa; the orbicular resting on this incurvation. Posterior line a little curved around the cell, then bent inwardly and again slightly outward near the costa. Subterminal line almost even. A terminal series of black dots. Orbicular very slightly darker than the ground color, pale-ringed. Hind wings fuscous. Expanse, 28–30 mm.

Common everywhere from May to July.

Tæniocampa alia *Guen.*

Fore wings varying from reddish brown to grayish fuscous or gray, more or less clouded with blackish in paler specimens. Transverse lines very ill defined or wanting. Subterminal line distinct, pale grayish. Median shade, when present, reddish or blackish. Orbicular rather large, oval, gray-ringed. Reniform constricted in the middle lower part, filled with blackish. Hind wings grayish fuscous, fringes paler. Head and thorax concolorous with fore wings. Expanse, 32–40 mm.

A rather common species in this neighborhood. The moth flies in March and April and again late in fall. The species is subject to considerable variation.

Tæniocampa subterminata *Smith.*

Plate LIX, Fig. 22.

Fore wings varying from gray to cinnamon-brown. Transverse lines more or less distinct. Basal half line present. Anterior line oblique, wavy. Posterior line almost parallel with the outer margin, outer portion punctiform. Median shade line upright, usually very distinct. Subterminal line always very distinct, pale, outer portion

marked with dark brown or black. Ordinary spots rather large, pale-ringed, usually concolorous or rarely darker than the ground color. Claviform more or less traceable. Hind wings variable in color, from gray to brownish. Head and thorax concolorous with the fore wings. Expanse, 35–40 mm.

Very rare in this vicinity. The moth is on the wing in April and May and possibly again late in fall.

Calymnia orina (*Guen.*).

Plate LIX, Fig. 23.

Fore wings light yellow with fawn-colored suffusions, varying to entirely fawn color without yellow. Basal line very oblique running nearly to the middle of the wing on the inner margin. Posterior line bent opposite the cell, then almost evenly oblique to the inner margin. Orbicular very small, round. Reniform larger, upright, yellow-ringed in yellow specimens, and filled with dusky in fawn-colored specimens. Median shade more or less distinct. Hind wings yellowish or tinged with fawn color. Expanse, 26–32 mm.

Caterpillar. — Head rather smooth, pale whitish green, with a few fine yellowish hairs, not visible without a lens. Body above pale green, with a dorsal yellow line, less distinct on the anterior segments, and covered with fine dots and short yellow streaks, less numerous on the second and last segments. A few short yellowish hairs are scattered over the surface similar to those on the head. Spiracles small, oval, whitish, encircled with dull red. Underside slightly darker green with many minute yellowish white dots. Feet pale and shining. Abdominal legs green, tipped with brown. Length, 23 mm.

Foot-plant. — Oak.

Quite rare in this vicinity. The moth flies in July and August.

Ipimorpha pleonectusa (*Gr.*).

Plate LIX, Fig. 24.

Fore wings almost uniform light brown. Transverse line very narrow, dull yellow. Ordinary spots a little darker than the ground color, narrowly ringed with yellow. Basal line straight. Anterior line a little oblique. Posterior line parallel with the outer margin. Median shade line upright. Subterminal line wavy. Orbicular round. Reniform large, constricted in the middle on each side. Hind wings brown, a little paler than the fore wings. Head and thorax concolorous with the fore wings. Expanse, 33 mm.

Quite rare in this vicinity. Found in July and August.

Atethmia rectifascia (*Gr.*).

Fore wings olive gray, fringes golden. Transverse anterior line upright, even, blackish. Transverse posterior line almost straight, slightly curved. Subterminal line straight. Hind wings silky sordid white, fringes golden. Thorax olive-gray. Top of head pale testaceous. Expanse, 26 mm.

A rare species. It may be known readily by the olive-gray fore wings, upright, even transverse lines, and golden fringes.

Cosmia paleacea (*Esper*).

PLATE LIX, FIG. 25.

Fore wings pale yellow more or less powdered with red or blackish, or almost uniform in color. Transverse lines narrow, single, reddish or blackish. Basal half line slightly oblique. Anterior line broadly angulate at the middle. Posterior line irregularly curved. Median shade line angulate. Ordinary spots like the ground color, narrowly ringed with reddish. Orbicular round. Reniform rather large, a little constricted at the middle. Subterminal line more or less defined, claviform, elongate. Hind wings pale yellowish, tinged with reddish. Expanse, 38–45 mm.

A very variable species. Found in August and September.

Pyrrhia umbra (*Hufnagel*).

PLATE LIX, FIG. 26.

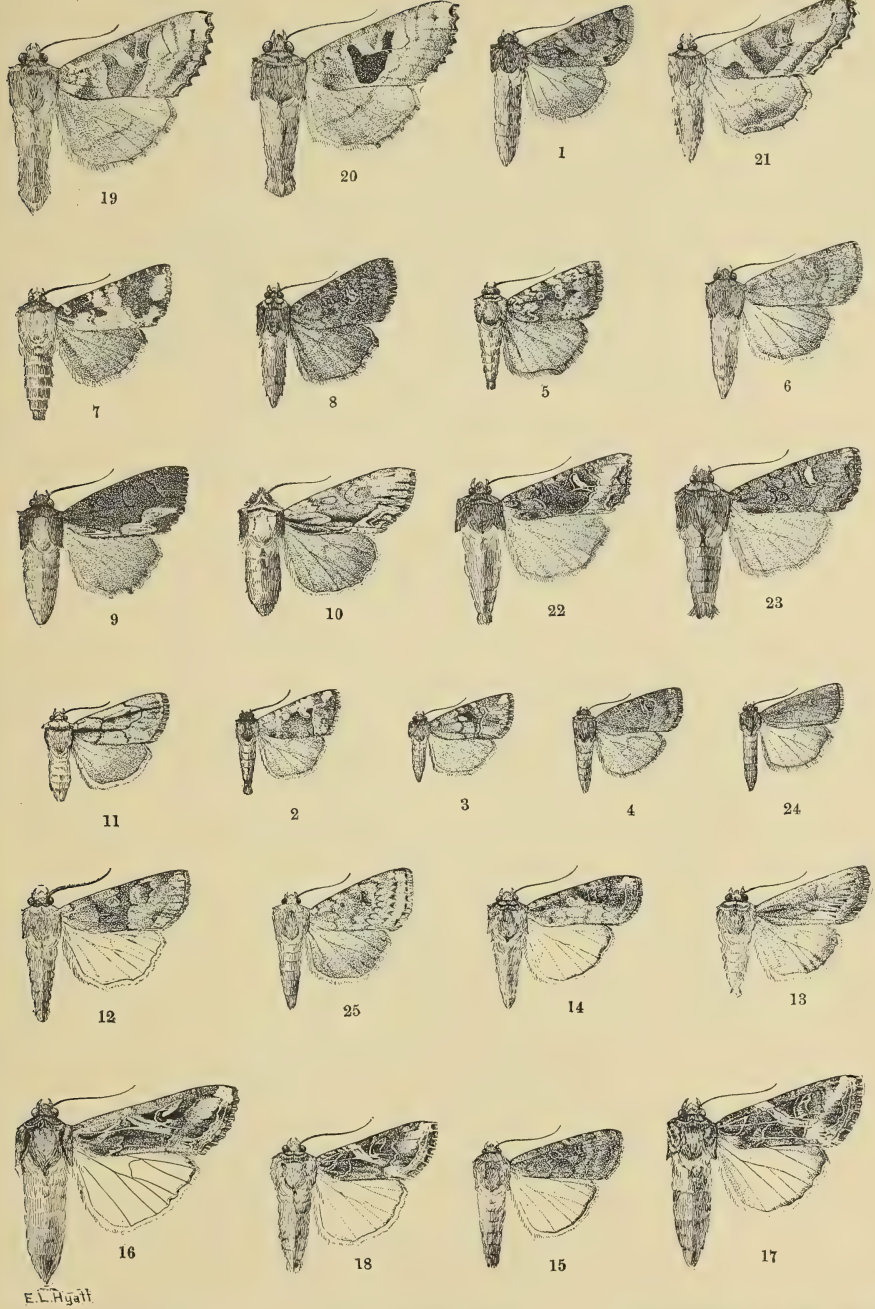
Fore wings bright rusty orange, dusted with rusty scales. Transverse lines rusty brown. Subterminal space rusty purple. Fringes purplish. Basal half line upright. Anterior line with three angles. Posterior line inwardly oblique, almost even, angulate at the costa. Median shade line distinctly angulate. Orbicular variable in size, round. Reniform rather large, inner part touching the median shade line. Subterminal line dentate. Hind wings testaceous, outer half blackish or reddish, fringes pale with a central blackish dot. Head and thorax rusty orange. Expanse, 30–38 mm.

Var. **exprimens** (*Walk.*). — Like *umbra* but with the median shade line considerably more angulated.

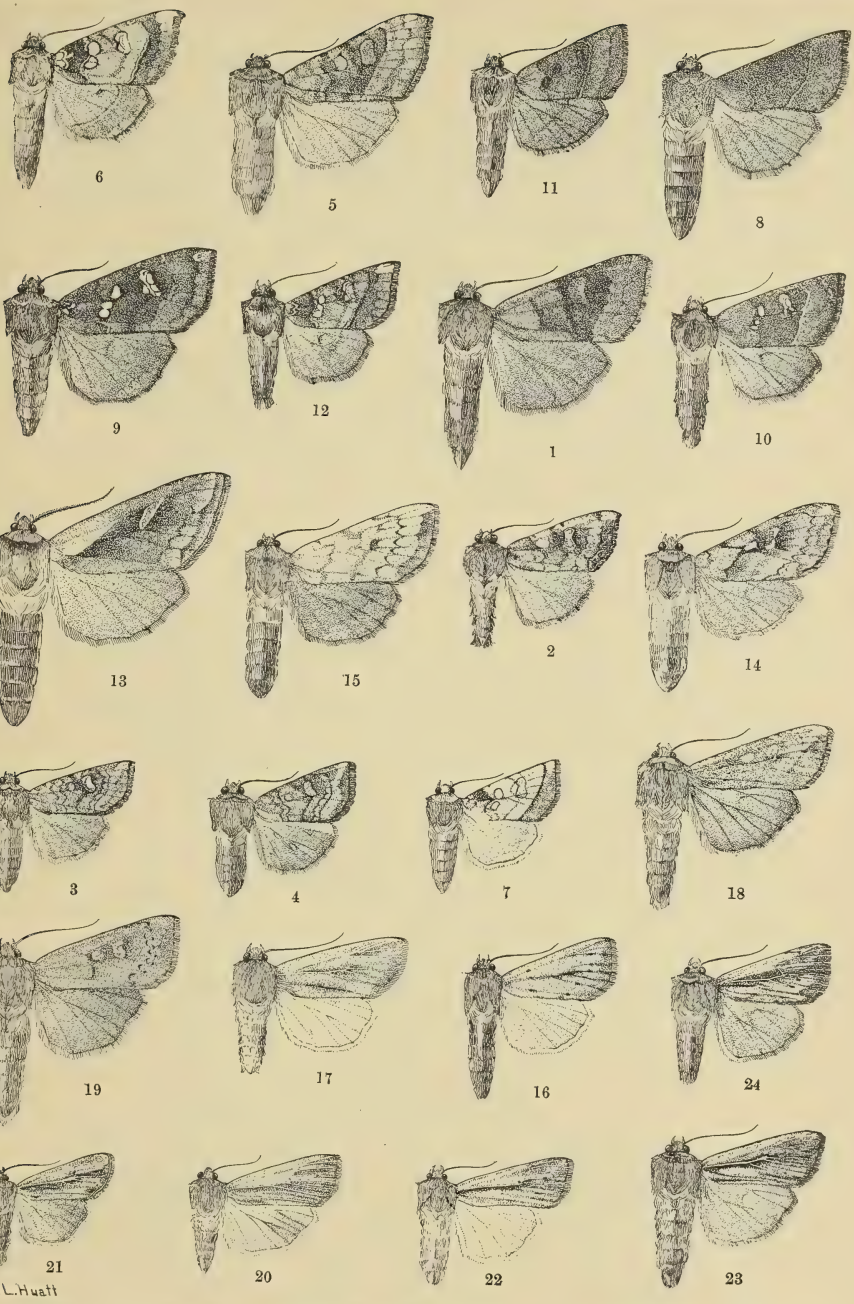
Caterpillar. — Head shining yellow, with a black dot on each side near the jaw. Body bluish white; a yellowish brown stigmatal stripe and about ten transverse black lines. Sometimes a dorsal row of yellowish brown spots. Piliferous spots black. Underside pale greenish. Length, 35 mm.

Food-plants. — Smartweed (*Polygonum*), *Desmodium*, blackberry.

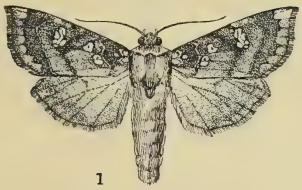
A rather common species found from May to September.



1. *Trachea delicata* Grote.
2. *Oligia festivoides* Guenée.
3. " *versicolor* Grote.
4. " *grata* Hübner.
5. *Perigea xanthioides* Guenée.
6. " *claufacta* Walker.
7. " *epopea* Cranier.
8. " *vecors* Guenée.
9. *Dipterygia scabriuscula* Linn.
10. *Hyppa xylinoides* Guenée.
11. *Homohadena badistriga* Grote.
12. *Adita chionanthi* A. & S.
13. *Oncocnemis riparia* Morr.
14. *Laphygma frugiperda* A. & S.
15. " *f.* var. *obscura* Riley.
16. *Prodenia commelinæ* A. & S.
17. " *ornithogalli* Guenée.
18. " *ludiopta* Guenée.
19. *Trigonophora periculosa* Guenée.
20. *Trigonophora p.* var. *v-brunneum* Grote.
21. *Brotolomia iris* Guenée.
22. *Helotropha reniformis* Grote.
23. " *r.* var. *atra* Grote.
24. *Caradrina miranda* Grote.
25. " *multifera* Walker.



1. *Nephelodes minians* Guenée.
2. *Gortyna velata* Walker.
3. " *nictitans* Linn.
4. " *n.* var. *erythrostigma* Haworth.
5. " *immanis* Guenée.
6. " *cataphracta* Grote.
7. " *rigida* Grote.
8. " *necopina* Grote.
9. *Gortyna cerussata* Grote.
10. " *nebris* Guenée.
11. " *n.* var. *nitela* Guenée.
12. " *harrisii* Grote.
13. *Bellura obliqua* Walker.
14. " *gortynides* Walker.
15. " *melanopyga* Grote.
16. *Nonagria subflava* Grote.
17. *Ommatostola lintneri* Grote.
18. *Heliophila unipuncta* Haw.
19. " *pseudargyria* Guenée.
20. " *pallens* Linn.
21. " *albilinea* Hübner.
22. " *phragmatidicola* Guenée.
23. " *commoides* Guenée.
24. " *insueta* Guenée.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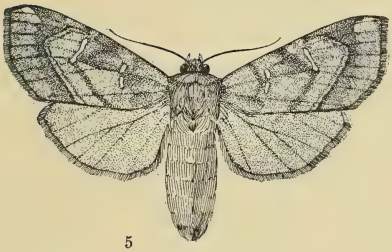
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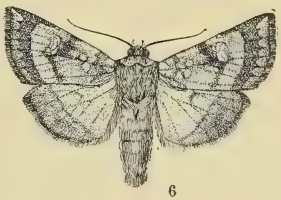
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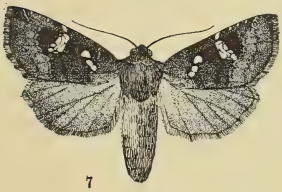
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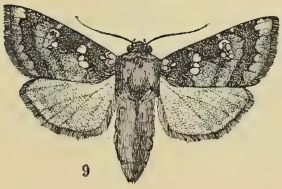
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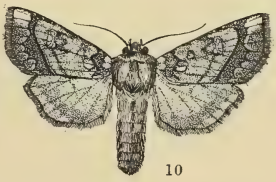
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E.L.Hyatt

1. *Gortyna duovata* (Bird).
2. " *marginidens* (Guenée).
3. " *inquæsita* G. & R.
4. " *rutila* (Guenée).
5. *Gortyna speciosissima* G. & R.
6. " *impecuniosa* Grote.
7. " *limpida* Guenée.
8. " *appassionata* Harvey.
9. *Gortyna baptisiæ* (Bird).
10. " *purpurifascia* G. & R.

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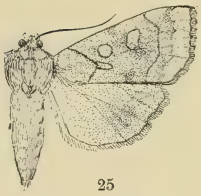
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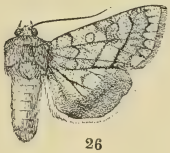
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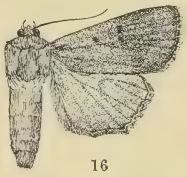
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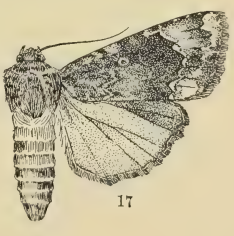
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1. *Dryobata illocata* Walker.
2. *Actinotia ramulosa* Guenée.
3. *Euthisanotia timais* Cramer.
4. *Euplexia lucipara* Linn.
5. *Achatodes zeæ* Harris.
6. *Platysenta videns* Guenée.
7. *Scolecocampa liburna* Geyer.
8. *Doryodes bistrialis* Geyer.
9. *Phiprosopus callitrichoides* Guenée.
10. *Amolita fessa* Grote.
11. *Balsa malana* (Fitch).
12. " *tristrigella* (Walker).
13. " *labecula* Grote.
14. *Catabena lineolata* Walker.
15. *Crambodes talidiformis* Guenée.
16. *Pyrophila tetrapogonis* Linn.
17. " *pyramidoides* Guenée.
18. *Orthodes cynica* Guenée.
19. *Orthodes crenulata* Butler.
20. *Crocigrapha normani* Grote.
21. *Tæniocampa oviduca* Guenée.
22. " *subterminata* Smith.
23. *Calymnia orina* Guenée.
24. *Ipimorpha pleonectusa* Grote.
25. *Cosmia paleacea* Esper.
26. *Pyrrhia umbria* (Hufn.)

Article XXXIV. — THE HAIR SEALS (FAMILY PHOCIDÆ) OF THE NORTH PACIFIC OCEAN AND BERING SEA.

By J. A. Allen.

Figs. 1–10.

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Introduction.

Among the mammals collected by Mr. N. G. Buxton and Mr. W. Bogoras in northeastern Siberia, on the Jesup North Pacific Expedition, are specimens of three species of Hair Seals. An attempt to identify these has rendered necessary their comparison with such other material from northeastern Asia and northwestern North America as could be brought together, so that the present paper may be considered as a preliminary revision of the seals of the family Phocidæ known to occur in the North Pacific. Although the material available for examination is scanty, it is sufficient to show that the name *Phoca largha* Pallas, as recently misapplied, includes at least three species, the proper identification of which involves the consideration of difficult questions of synonymy.

In this connection it gives me pleasure to acknowledge my indebtedness to Mr. Gerrit S. Miller, Jr., Curator of Mammals in the U. S. National Museum, for kindly securing for me the

use of the material under his charge, consisting of specimens from the coast of Alaska, the Commander Islands, and the eastern coast of Kamschatka; and to Mr. Witmer Stone of the Academy of Natural Sciences of Philadelphia, and Dr. Horace Jayne, Director of the Wistar Institute of Anatomy and Biology of Philadelphia, for the large series of seal skulls collected by Mr. E. A. McIlhenny at Point Barrow; and to Mr. Outram Bangs, Curator of Mammals at the Museum of Comparative Zoölogy, Cambridge, Mass., for several skulls of special interest. I am also greatly indebted to Dr. L. Stejneger for field notes and measurements of the seals collected by him at the Commander Islands and on the coast of Kamschatka, without which and the specimens collected by him there would have been little basis for the present paper.

I must confess much disappointment in finding so little material available for the study of the seals of the Pacific coast of North America. Applications made to the three leading Natural History Museums of the Pacific coast for skulls of California seals resulted only in the information that these institutions had none in their collections. It was also a matter of surprise to find that the U. S. National Museum had so few skulls of seals from Alaska and the Pribilof and other Alaskan Islands, considering the large number of naturalists and collectors who have visited this region in its interests in recent years. The only material available for examination from south of Puget Sound consists of one skull and one mounted specimen from the Santa Barbara Islands.[1] There are two immature specimens (and some fragments of others) from the vicinity of Puget Sound, two skulls only from Alaska south of St. Michaels, a small series of quite young skulls from St. Michaels, and three from the Pribilof Islands. Furthermore, none of this material is identified as to sex. In animals which vary so greatly with age and sex as do the seals of the present group, the inadequacy of such material as I have been able to bring together, as regards both quantity and quality, for more than a superficial view of the field is readily

[1] As these pages are passing through the press I am in receipt, from Dr. C. Hart Merriam, Chief of the Biological Survey of the U. S. Department of Agriculture, of four skulls of *Phoca* from San Geronimo Island, Lower California, as noted below, p. 493.

apparent. It may, however, serve to direct attention to this neglected group of mammals, and possibly stimulate the gathering of material for the use of future investigators.

The case is hardly better when we turn to the seals of the eastern coast of North America. While the Harbor Seal of southern Greenland appears to differ, at least sub-specifically, from that of the coast of New England and New York, very little material bearing on the question can be obtained. Nor is there much for the comparison of the Harbor Seal of eastern North America with the Harbor Seal of Europe.

Nomenclature.

The Generic Name Phoca.

First, as to the generic name *Phoca*. As shown by me many years ago (Hist. N. Am. Pinnipeds, 1880, pp. 417, 418, 558) the process of elimination, strictly enforced, would necessitate the restriction of the name *Phoca* to the *Phoca leonina* Linn. Linnæus in 1758 (Syst. Nat., 10th ed., pp. 37, 38) included four species in the genus *Phoca*, namely, (1) *Phoca ursina*, (2) *Phoca leonina*, (3) *Phoca rosmarus*, (4) *Phoca vitulina*. *Phoca rosmarus* was removed by Linnæus in 1776 to *Trichechus*, and *Otaria* was established in 1816 for the Eared Seals, leaving in *Phoca* at this date only *Phoca leonina* and *Phoca vitulina*. In 1826 *Phoca vitulina* was made by F. Cuvier the type of his genus *Calocephalus*, and *Phoca leonina*, in the same memoir, was made the type of his genus *Macrorhinus*, leaving nothing to represent the old Linnæan genus *Phoca*. *Calocephalus*, however, has precedence by eighteen pages over *Macrorhinus*. Besides this, *Macrorhinus* of F. Cuvier is preoccupied by *Macrorhinus* Latreille, 1825, for a genus of Coleoptera, and has had to give way to *Mirounga* Gray, 1827. When *Calocephalus* was established, only *Phoca leonina* was left to bear the restricted name *Phoca*. In view of all this, plainly set forth in 1880, when rules of nomenclature were less rigidly enforced than at present, I then pleaded for the retention of *Phoca* as the generic name of the Harbor Seal, as follows: "This, however, seems so contrary to the traditions

of *Phoca*, which from 1735 to the present day has been generally associated by the majority of writers with *vitulina* and its nearest allies, that it seems an act of violence to transfer it to what is logically its legitimate connection with *leonina*, thereby making *Macrorhinus* a synonym of the restricted genus *Phoca*. . . . In view of the tradition and usage of the case it seems best to waive the technicality here involved and suffer *Phoca* to retain its time-honored associations."

The only way, however, to retain *Phoca* for the *Phoca vitulina* group is to invoke Canon XXIII of the American Ornithologists' Union 'Code of Nomenclature,' which provides as follows: "If, however, the genus contains both exotic and non-exotic species,—from the standpoint of the original author,—and the generic term is one originally applied by the ancient Greeks or Romans, the process of elimination is to be restricted to the non-exotic species." As the Harbor Seal is, or was formerly, a common species in the Mediterranean, as well as on the western shores of Europe, and was the only seal really known, not only to the ancients but to the early natural-history writers, as Rondelet, Olaus Magnus, Gesner, and Aldrovandus, and down to about 1750, it meets the requirements of Canon XXIII as against its competitor, the *Phoca leonina* of Linnæus, which was practically first made known by Lord Anson in 1748.

Specific Names.

In case the Harbor Seal of eastern North America proves separable from true *Phoca vitulina* of Europe, as seems almost certain, an available name for the southern form is found in *Phoca concolor* Dekay (1842), based on New York examples of the light phase.

The nomenclature of the North Pacific species seems at first sight highly complicated, but a careful examination of the early names shows that they have very little basis and that most of them should be rejected as unidentifiable. The names to be here especially considered are, in the order of date, as follows: (1) *Phoca largha* Pallas, 1811; (2) *Phoca*

ochotensis Pallas, 1811; (3) *Phoca tigrina* Lesson, 1827; (4) *Phoca chorisi* Lesson, 1828; (5) *Phoca nummularis* Temminck, 1842; (6) *Halichœrus antarcticus* Peale, 1848; (7) *Halicyon richardii* Gray, 1864; (8) *Phoca pealii* Gill, 1866; (9) *Halicyon ? californica* Gray, 1886. Only five of these names —*Phoca largha* Pallas, *Phoca ochotensis* Pallas, *Halichœrus antarcticus* Peale, *Phoca nummularis* Temminck, and *Halicyon richardii* Gray — are entitled to serious consideration.

The *Phoca tigrina* of Lesson was based on the 'Phoque tigré,' figured by Kraschenninikow in his 'Histoire de Kamtschatka' as inhabiting the coast of Kamschatka, and may be either of three very distinct species of spotted seals now known to inhabit this coast, and is therefore unidentifiable.

The *Phoca chorisi* of Lesson, founded on a figure by Choris, published without any descriptive detail (Voy. Pittoresque, plate viii), of his 'Chien de mer de Détroit de Behring,' is likewise indeterminate.

Phoca pealii Gill is a synonym of *Halichœrus antarcticus* Peale, the latter being an avowed substitute for Peale's name.

Gray's *Halicyon ? californica*, based on the "Hair Seal, *Phoca jubata*" of Hutching (Scenes of Wonder and Curiosity in California, p. 189), has of course no standing.

Taking up the other names in chronological order, the first is the *Phoca largha* of Pallas, which has of late been revived for the large spotted seals of the North Pacific, and used, as the present material shows, for the designation of several quite distinct species. Pallas's *Phoca largha* is, however, unidentifiable and therefore not available for any of the species to which it has been applied. His description,[1] based on an imperfect skin, which lacked the head, is not diagnostic, there being no indication of the size of the animal, nor mention of any character that may not apply to any of the several species of spotted seals found along the coast of Kamschatka. He gives the Russian name as 'Nerpa,' and says that it is also called 'Largha' on the eastern coast of Kamschatka. According to Mr. Buxton's notes, the name Nerpa is applied,

[1] "P. capite — — — corpore supra nitide albente, maculis nigris ovalibus sparso." —Zoog. Rosso-Asiat., I, 1811, p. 133.

on the Siberian coast, to *Erignathus barbatus*, and the name Largha to the larger spotted seal of the same region.

The history of the use of the name *Phoca largha* Pallas is briefly as follows: In 1850 (Cat. Seals, p. 54) and later (Cat. Seals and Whales, 1870, p. 24) Dr. J. E. Gray identified it with Temminck's *Phoca nummularis*. It having been found that the spotted seals of the Pribilof and Commander Islands were not *Phoca vitulina*, Pallas's name *largha* has recently been applied to them, without, however, any discussion of its availability. It appears to have been first used in such a connection by Dr. L. Stejneger in 1896, in his report on 'The Russian Fur-seal Islands' (Bull. U. S. Fish. Comm., Vol. XVI, 1896, p. 21), where *Phoca largha* appears in a brief enumeration of the marine mammals occurring on the Commander Islands. When this report was republished two years later in Jordan's 'Report on the Fur Seals and the Fur-Seal Islands of the North Pacific' (Part IV, 1898, p. 30) a footnote was added, referring to the name *Phoca largha*, stating: "During 1896 there were killed 49 'Nerpi' on Bering Island and 22 on Copper Island," thus again connecting the name Nerpa with *Phoca largha*. Mr. F. W. True in 1899 (Jordan's Fur Seal Report, Part III, p. 351), in a paper on the 'Mammals of the Pribilof Islands,' tentatively used the name "*Phoca largha* Pallas ?" for "the hair seal found about the islands," apparently taking Dr. Merriam as his authority for its probable identification "with the *P. largha* of Pallas."

It is doubtless on this basis that the name was used, *passim*, in the same volume by Messrs. Stiles and Hassell in their memoir on the 'Internal Parasites of the Fur Seal,' in enumerating the hosts of the various species of parasites there described. The name has since been accepted in the same sense by Mr. Witmer Stone (Proc. Acad. Nat. Sci. Phila., 1901, p. 43); by Mr. D. G. Elliot (Synop. N. Am. Mamm., Dec., 1901, p. 363), and by Miller and Rehn (N. Am. Mamm., Dec., 1901, p. 194). The material now in hand and referred to respectively by Stejneger, Merriam, True, and Stone, shows that the name as used by these authors covers three very distinct species, as will be shown later in the present paper.

Pallas's *Phoca ochotensis* (Zoog. Rosso-Asiat., I, 1811, p. 117) seems available for the larger spotted seal of the Okhotsk Sea, as will be shown later in treating of that species.

The next name requiring careful consideration is the *Phoca nummularis* Temminck (Fauna Japonica, Mamm. Marine, 1842, p. 3). He says: "Le troisième Phoque des parages septentrionaux de l'océan pacifique nous est connu d'après trois jeunes individus et d'après un nombre égal de peaux incomplètes d'individus adultes, tous rapportés du Japon par M.M. de Siebold et Bürger. C'est évidemment le deuxième Phoque de Steller, Descr. du Camtsch. p. 107, et l'espèce dont Pallas fait mention en traitant du Phoque commun, l. c. [Zoog. Rosso-Asiat., I,] p. 117, nota 2; puis le Phoque, figuré sans le moindre détail descriptif, dans le voyage de Choris, Pl. 8, sous le nom de Phoque du détroit de Behring; peut-être convient-il également de rapprocher de cette espèce inédite le *Phoca largha* de Pallas, ibid. p. 113, nº 43. Quoi qu'il en soit, nous avons cru devoir conférer à ce Phoque le nom qu'il porte, suivant Pallas, l. c. p. 117, chez les Russes, savoir celui de Phoque nummulaire, *Phoca nummularis*."

Temminck describes his six skins in detail, and comments upon their wide range of color-variation. He also describes the three imperfect skulls that accompanied the skins, and points out their resemblance to the skull of the "Phoque à croissant [*Phoca grœnlandica*], notamment par la configuration de la région interorbitaire, qui est, par devant, plus large que dans le crâne du Phoque annelé [*Phoca hispida*]. Quant au système dentaire, il n'offre pas la moindre disparité de celui du Phoque à croissant et du Phoque annelé." He concludes: "Ce Phoque est en quelque sorte intermédiaire entre le Phoque à croissant . . . et le Phoque annelé . . .; car il offre beaucoup d'analogie avec le premier par la configuration de son crâne, notamment par celle de la région interorbitaire ainsi que par celle de ses dents, tandis qu'il se rapproche davantage du second par son système de coloration."

Later the skull fragments described by Temminck were examined by J. E. Gray, who states (Proc. Zoöl. Soc. London, 1864, pp. 31, 32) that "they are nearly all from very young

specimens of nearly the same age." He compares these fragments with the corresponding parts in *Phoca fœtida* and says: "The general form and size of the face, and the form of the teeth, are very similar to those of a skull of *Pagomys fœtidus* of the same age." He adds that "the grinders" are "larger, thicker, and rather closer together, the central lobe of the grinders being considerably larger, thicker, and stronger, and all of the lobes of the grinders being more acute." Gray's comparative measurements of *Phoca fœtida* and *P. nummularis* show that the latter is very much smaller than *P. fœtida* and indicate a species much below the size of any species of *Phoca* known to me. The name *Phoca nummularis*, therefore, cannot apply to any of the species represented by the material here under consideration. All that we thus far know of *Phoca nummularis* points to a species very similar in coloration to *Phoca fœtida*, but smaller and with heavier dentition—features which may characterize a species of seal found in Japan, and still practically unknown, and certainly not known to occur elsewhere.

The next name in order of date is *Halichœrus antarcticus* Peale. As long since pointed out by Dr. Gill (Proc. Essex Inst., Vol. V, 1866, p. 4, footnote), "The *Halichœrus antarcticus* of Peale . . . is a typical species of *Phoca*"; and he adds that it "appears to be identical with a species occurring along the California and Oregonian coasts, and consequently there must be some error as to its assigned habitat in the Antarctic seas. I am happy to add that Mr. Peale himself now doubts the correctness of the labels on the faith of which he gave its habitat [Desolation Island], and as a change of name is desirable, I would propose that of *P. pealii*." I have examined this skull,[1] but cannot quite agree with Dr. Gill in his determination of the species. It is a rather young skull and apparently a female, but in one important particular it does not agree with the Harbor Seal occurring along the Pacific coast of the United States. Since, however, it does agree with the Atlantic coast form, the name must be synonymized with *Phoca vitulina*. Where the skull actually came

[1] See Hist. N. Amer. Pinnipeds, 1880, pp. 580, 581, figs. 44, 46.

from, and how it obtained its erroneous locality label, are mysteries that will probably never be solved. As shown by my figures of the specimen (*l. c.*, p. 580, fig. 45), the premaxillæ scarcely reach the nasals, instead of touching them for a greater or less distance, as in all of the Pacific coast specimens of the *Phoca vitulina* group available for examination (see *postea*, p. 471). We are thus fortunately able to avoid the use of the very objectionable name *antarcticus* for any of the North American species of *Phoca*.

The next name in order of date is the *Halicyon richardii* of Gray, 1864 (P. Z. S., 1864, pp. 28–31, figs. 1 and 4), based on specimens from "Fraser's River and Vancouver Island." Later (Cat. Seals and Whales, 1866, p. 301) these are said to consist of a skeleton from Fraser's River and a skull "obtained from the west coast of Vancouver's Island." Mr. J. W. Clark, however, says (P. Z. S., 1873, p. 336) that *Halicyon richardii* Gray was "described from a single skull from Vancouver Island." Which of the skulls is figured is not stated. The name is available for the Hair Seal of Vancouver Island and neighboring coasts, and is the first name unequivocally pertinent to any North Pacific seal of the *Phoca vitulina* group.

Sexual Differences in Dentition in Phoca vitulina.[1]

Figs. 1–4.

There are eleven skulls of Harbor Seals in the osteological collection of the American Museum of Natural History, of which ten have the sex indicated, the specimens having been received at the Museum in the flesh from various menageries, chiefly from the Central Park Menagerie and the Aquarium, New York City. They are all 'young adults,' from unknown localities, but presumably all are from the eastern coast of the United States and probably mostly from the coast of Maine. The sexed skulls embrace three males and seven

[1] In the absence of a series of authentic skulls of the true *Phoca vitulina* of Europe, the name is here used only tentatively for the so-called Harbor Seal of the Atlantic coast of North America. This seal certainly differs from any seals of the Pacific coast of North America, and in all probability is separable from the Harbor Seal of Europe. In case this proves to be as here conjectured, the name *Phoca concolor* Dekay, as said above, will be available for the seal of the eastern coast of the United States.

females. In addition to these are two skulls from the coast of Maine, sexed as male and female, received for examination from the U. S. National Museum, making 13 in all. This material shows that the toothrow in the females is fully as long as in the males, but that the individual teeth are very much heavier in the males, so that while in the females the teeth, except pm^2 and pm_3, stand in a straight line one behind the other, with little or no obliquity of insertion, in the males the teeth are so much larger that there is not room for them in a straight line, and the axis of insertion for two of the upper and three of the lower teeth (pm^{2-3} and pm_{2-4}) is more or less oblique to the axis of the jaw, the divergence in the two axes amounting in some cases to fully 45°.

Male. — In the male pm^1 is small and conical and generally has a more or less oblique insertion at the postero-inner base of the canine; pm^2 and pm^3 are much larger, subequal, and inserted obliquely to the axis of the toothrow, the angle being greater in pm^2 than in pm^3, and varying in different individuals; in pm^4 and m^1 the axis of insertion is usually parallel to the axis of the tooth row.

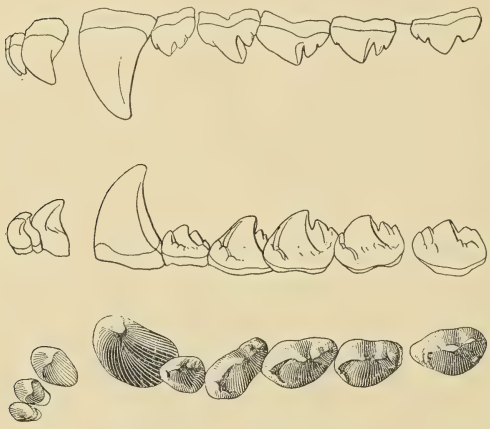

Fig. 1. *Phoca vitulina*, 'young adult' ♂. Am. Mus. No. 13969, probably from coast of Maine. Upper dentition, outside, inside, and crown views of teeth. Nat. size.

The upper teeth, except pm^1, are usually tricuspid, pm^2, pm^3, and pm^4 having a main cusp — high, pointed, and directed backward — and two accessory cusps behind it, the anterior cusp being either wholly suppressed or present as a rudiment. In pm^3 the posterior cusp is sometimes suppressed or so rudimentary that the tooth is practically bicuspid instead of tricuspid. The same exceptional con-

dition occurs less frequently in pm^2. The molar is tricuspid, but in a different way, there being an accessory cusp both before and behind the main cusp; the accessory cusps are subequally developed, but generally the posterior is larger than the anterior, which latter is sometimes quite obsolete.

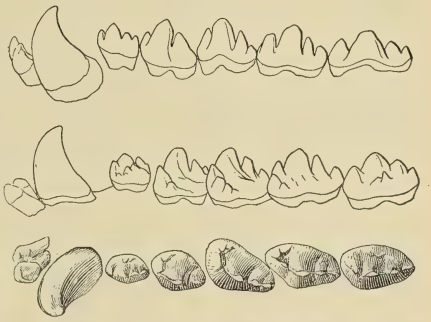

Fig. 2. *Phoca vitulina*, 'young adult' ♂. Am. Mus. No. 13969, probably from coast of Maine. Lower dentition, outside, inside, and crown views of teeth. Nat. size.

In the lower jaw the teeth are much heavier than in the upper jaw, more serrated, more crowded, and more given to the development of what may be termed adventitious cusps. Pm_{2-4} normally considerably overlap each other and have a very oblique insertion, pm^2 and pm_3 being set rather more obliquely than pm_4, the molar alone usually having the axis of insertion parallel to the axis of the tooth-row. The teeth are usually 4-cusped, but not infrequently 5-cusped, more rarely 6-cusped, there being a main, high-pointed cusp, with two well defined cusps behind it and one or two, and sometimes three, in front of it, the inner front border of the cingulum in heavy unworn teeth being often serrated with cusplets which increase in size toward the main cusp. The molar has normally four simple subequal cusps, the second or main one being the

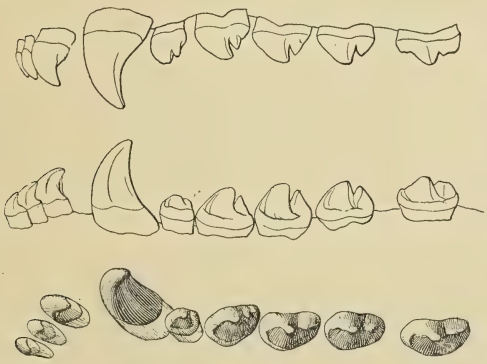

Fig. 3. *Phoca vitulina*, 'young adult' ♀. Am. Mus. No. 14442, probably from coast of Maine. Upper dentition, outside, inside, and crown views of teeth. Nat. size.

largest and the second posterior cusp the smallest; sometimes there are two points in front of the main cusp, making five in all; sometimes the last posterior cusp is obsolete or barely indicated, its development greatly varying in different specimens. In addition to the variations above noted in the number of cusps on the molar, a cusp, sometimes of considerable size, but usually rudimentary, is developed at the inner base of the main cusp, and in rare instances another, much smaller, at the base of the cusp next behind the main cusp.

Female. — The teeth are about one half smaller and less obliquely inserted than in the male, and often vary from the male dentition in the reduction of the cusps, both in size and number. The internal accessory cusps, so often seen in the male, seem to be uniformly absent.

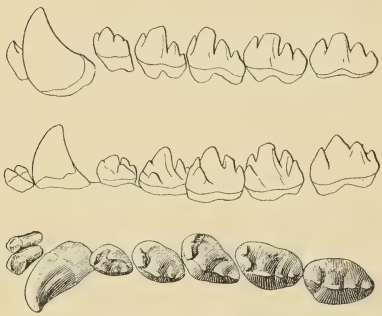

Fig. 4. *Phoca vitulina*, 'young adult' ♀. Am. Mus. No. 14442, probably from coast of Maine. Lower dentition, outside, inside, and crown views of teeth. Nat. size.

The teeth vary notably in the development of cusps in both sexes, as does also the size of the teeth. Some females have nearly as heavy dentition as some males, so that through the wide range of individual variation in this respect, one cannot be sure whether in skulls not marked for sex a skull with rather weak dentition is a heavy-toothed female or a light-toothed male.[1]

[1] Among the thirteen skulls here under consideration are three that differ strikingly from the rest of the series. Two of them were received from Messrs. Barnum and Bailey, and the other, at about the same date, from the Central Park Menagerie. These three skulls, sexed as female, uniformly differ from the others in having only three cusps instead of four on the lower molar. In one (No. 6366) there is a rudimentary second posterior cusp, about as large as a small pin point. This skull agrees with the only skull (No. 32) of known European origin available for examination, and I strongly suspect that these three aberrant skulls are also European, and that the animals were obtained through the well-known European dealer in menagerie specimens, Carl Hagenbeck. If this conjecture is correct, the difference in the form of the last molar will serve as a good distinguishing character between the females of the European and North American Atlantic coast Harbor Seals.

These same skulls differ from the other female skulls in lacking one cusp throughout both the upper and lower premolar-molar series, the upper premolars lacking the second posterior cusp, being bicuspid instead of tricuspid, while in the lower jaw there is a corresponding reduction in the number of cusps.

Comparison of the Atlantic and Pacific Forms of the Phoca vitulina Group.

The skulls of the *Phoca vitulina* group available for study from the coasts of the North Pacific and Bering Sea number 26. They include 1 from Santa Barbara Islands; 2 from Puget Sound; 1 from Yakutat Bay; 1 from Kenai, Alaska; 1 from Adakh Island, Aleutian Islands; 4 from St. Michaels. To these may be added 4 from Point Barrow; 3 from the Pribilof Islands; 4 from Bering Island; 2 from Avatcha Bay, Kamschatka; 5 from mouth of Gichiga River, Okhotsk Sea. The Point Barrow, Kamschatkan, and Okhotsk specimens, however, represent species quite distinct from those from the Pacific coast of North America. Hence the really available material for comparison with the Atlantic coast specimens consists of the skulls from the Pribilof Islands and St. Michaels, Alaska, and a few from more southern points on the Pacific coast. These are nearly all young, and not one is identified as to sex. The general appearance of the St. Michaels skulls seems to indicate that three of them are females and the other a male. These and the other Pacific coast skulls, compared with Atlantic coast skulls of closely corresponding ages, show the following resemblances and differences.

Cranial Differences. — In the Pacific coast skulls the premaxillæ ascend not only to the nasals but extend posteriorly so as to touch the sides of the nasals for about 8 to 10 mm.; in the Atlantic coast specimens the premaxillæ barely touch the nasals (in some cases do not quite reach them)—a distinction, according to Dr. True, first made known by Dr. Merriam.[1] This distinction appears to be constant in all the skulls I have examined from the Alaskan and Kamschatkan coasts, as compared with those of the Atlantic coast.

Dental Characters. — A careful comparison of the Alaska and Puget Sound skulls, tooth by tooth, with the Atlantic coast specimens, reveals no tangible differences between the

[1] *Cf.* True, in Jordan's 'Report on the Fur Seals and Fur-Seal Islands of the North Pacific Ocean,' Part III, 1899, p. 351. At a meeting of the Biological Society of Washington, held Jan. 30, 1897, Dr. Merriam is recorded (Proc. Biol. Soc. Wash. XI, 1897, p. viii) as having presented a communication on 'The Pribilof Island Hair Seal,' but the paper does not appear to have been published.

two series. In all of the Pacific coast skulls that have the general appearance of being female the lower molar has only three cusps, while all the skulls that are apparently male have four, as in the Atlantic coast form. Thus in No. 9480 (Nat. Mus.), from Kenai, No. 21476, from St. Michaels, and No. 6486 from Washington the lower molar has four cusps, as in male skulls from the Atlantic coast. The premolars are also all similar in the two series, except for the larger size of the teeth of the males, in both series. This is contrary to Dr. Merriam's discovery (as reported by Dr. True, *l. c.*), that: "In *P. vitulina* the lower premolar [=premolars ?] and molar have usually four cusps each, but in the Pribilof seal three." A large fully mature skull from the Pribilof Islands (Nat. Mus. No. 49550), apparently a female, and probably one of the skulls examined by Dr. Merriam, agrees with the supposed female skulls from St. Michaels. In another Pribilof skull, from St. George Island (Nat. Mus. No. 101330), also without indication of sex but apparently a male, the lower molar has four cusps, as in *Phoca vitulina.*

In a very old heavily ossified skull (Mus. Comp. Zoöl. No. 6157) from Santa Barbara Islands, evidently a male, the right lower molar has four cusps, and the left lower molar three, with the fourth distinctly indicated but very small.

In a series of four skulls from Bering Island, collected by Dr. Stejneger, unmarked as to sex, three of which are very old and the other quite immature, the lower molars in all of the old skulls are distinctly 4-cusped; in the young skull the left lower molar is just as distinctly 3-cusped, while the right lower molar is 4-cusped! (See Fig. 9, p. 490.) Also, in four skulls (received since the above was put in type) from San Geronimo Island, L. Cal., two of which are male and two female, the number of cusps on the lower molar varies in both sexes and also on the two sides of the same jaw from three to four.

The relative size and mode of implantation of the teeth in the jaws (both upper and lower) is the same in specimens from the west coast of North America as in those from the east coast, with the same great sexual difference in size, and in the position of the teeth in the jaw.

From the foregoing it is evident that the number of cusps, whether three or four, is in part a sexual character, and in part due to individual variation, and does not serve to distinguish Atlantic coast from Pacific coast specimens.

Supernumerary Teeth. — In addition to the tendency to the development of supernumerary or adventitious internal cusps on the last molar, and to individual variation in the number of what may be termed normal cusps, already noted, the frequency of supernumerary teeth in the seals of the *Phoca vitulina* type is a matter of interest. The series of 26 North Pacific and Bering Sea skulls contains 5 cases of supernumerary teeth, as follows:

No. 6970, Mus. Comp. Zoöl., Plover Bay, Siberia. Alveolus on left side for a supernumerary pm, in front of pm^1, apparently of nearly the normal size of pm^1.

No. 21312, Nat. Mus., Bering Island. A supernumerary incisor between i^1 and i^2 on the right side, nearly equalling in size the normal incisors.

No. 101330, Nat. Mus., St. George Island, Pribilof Islands. Supernumerary premolar on right side, between pm^3 and pm^4, about the size and shape of pm^1; on the left side a supernumerary tooth between pm^4 and the molar, also of about the size and shape of pm^1.

No. 82820, Nat. Mus., Coast of Maine. A supernumerary premolar in the lower jaw, *inside the tooth line* opposite pm_1 on the left side, larger than a normal pm_1, and in form a miniature pm_2.

No. 22, McIlhenny Collection (Acad. Nat. Sci. Phila.), Point Barrow, Alaska. A supernumerary tooth inside the tooth line on the right side, opposite pm^1, and about one third the size of a normal pm^1.

North Pacific Phocidæ.

1. **Erignathus barbatus** (*Fabricius*).

Bearded Seal.

Erignathus barbatus Murdoch, Rep. Point Barrow Exped. 1885, 95 (Point Barrow). — Nelson & True, Rep. Nat. Hist. Coll. Alaska, 1887,

259 (St. Michaels, Sledge Islands, Cape Prince of Wales, Alaska).—Stone, Proc. Acad. Nat. Sci. Phila., 1900, 43 (Point Barrow).

Siberian specimens do not appear to differ appreciably from Greenland examples, on comparison of series of six or eight skulls of each. Mr. Bogoras, however, informs me that the form occurring in the Okhotsk Sea is considerably smaller than that found along the northeastern coast of Siberia.

According to Mr. Nelson, the Bearded Seal is "rather common along the Alaskan coast of Bering Sea south to Bristol Bay." Murdoch states that it is not rare at Point Barrow, where it occurs at all seasons, but is most common in summer and autumn. On the Siberian side it ranges southward to the Okhotsk Sea, where several specimens were secured by Mr. Buxton for the American Museum. Mr. Bogoras obtained others from the Anadyr coast, northeastern Siberia.

2. **Histriophoca fasciata** (*Zimmerman*).

Ribbon Seal.

Phoca dorsata Pallas, Zoog. Rosso-Asiat. I, 1811, 112, part (Olotura, coast of Kamschatka = Olintorsk of modern maps). *Cf.* Nordquist, Vega-Exped. Vetensk. Iakt. II, 1883, pp. 110, 111.

Phoca (*Histriophoca*) *fasciata* True, Amer. Nat. XVII, July, 1883, 798; Proc. U. S. Nat. Mus. VI, April, 1884, 417, 426, pll. xi–xiv, skull, osteological characters, and skeleton (Plover Bay, Siberia, and Cape Romanzoff, Alaska).

Histriophoca fasciata Nordenskiöld, Voy. Vega, Engl. ed. 1882, 563 (fig. of animal), 565, 590 (St. Lawrence Island, Bering Sea).—Murdoch, Rep. Point Barrow Exped., 1885, 97 (Point Barrow, rare).—True, in Jordan's Rep. Fur Seals and Fur-Seal Islands, part iii, 1889, 351 (St. Paul Island, as a straggler).

Phoca fasciata Nordquist, Vega - Exped. Vetensk. Iakt. II, 1883, 107, figs. 16–18, skull, fig. 19, color pattern (Kamschatka).—Nelson & True, Rep. Nat. Hist. Coll. Alaska, 1887, 261 (south to Cape Vancouver, Alaska).—Stejneger, Bull. U. S. Fish Comm., XVI, 1896, 21 (Commander Islands).

This species is restricted to the North Pacific, and appears to be rare on the Alaskan coast, and rather more common, but not numerous, on the coast of Siberia, occurring as far south, according to Von Schrenck, as the Okhotsk Sea. Pallas states that it was formerly found at the Kurile Islands.

Murdoch records it as of rare occurrence at Point Barrow, and True mentions the capture of a young female by sealers near St. Paul Island. Dall obtained specimens at Cape Romanzoff. Nelson gives its southern limit as "about the rocky shores of Nunevak Island and Cape Vancouver. Stray individuals may occur about the mouth of the Koskoquim River, but if so they are very rare."

(?) 3. **Phoca (Pagophilus) grœnlandica** (*Fabricius*).

HARP SEAL.

Phoca grœnlandica NORDQUIST, Vega-Exped. Vetensk. Iakt. II, 1883, 105 (ex *P. dorsata* Pallas). Reported as not seen east of White Island, off the Gulf of Obi.

Phoca grœnlandica NELSON & TRUE, Rep. Nat. Hist. Coll. Alaska, 1887, 263 (Wrangle and Herald Islands).—STEJNEGER, Bull. U. S. Fish Comm. XVI, 1896, 21 (Commander Islands, on the authority of previous writers.)

I have never seen a specimen of this species from the North Pacific. It was recorded in early days by Steller and Pallas as occurring on the coast of Kamschatka. Mr. Nelson mentions "a skin of a young specimen" brought to him at St. Michaels, by a native, from Cape Prince of Wales. He also states: "During the cruise of the 'Corwin' in the summer of 1881 I was fortunate enough to add a little to the known distribution of the 'Saddle-back.' While cruising among the ice about Wrangel and Herald Islands several adults were seen, some of which were within a very short distance of the vessel. On August 12, in particular, while we were steaming through the pack off the shore of Wrangel Island, two of these seals were seen close alongside. One came up within twenty yards of us and gazed curiously at the vessel as it pushed against a slowly-yielding mass of ice. The chestnut brown of the animal's head was very conspicuous, and I called Captain Hooper's attention to it, whereupon he said that he had seen a number of these animals in the pack along this coast while there the previous year. This is good evidence that the Saddle-back is a regular and not uncommon summer resident of the ice-pack northwest of Bering Straits, and it probably winters there as well. South of Bering Straits its range

appears to coincide very closely with that of the Ribbon Seal, but it is very much less common."

As already said, I have never seen a specimen of *Phoca grœnlandica* from the North Pacific, nor from Bering Sea, nor can I find any record of a specimen taken in these waters except as recorded by Pallas, who refers, under his *Phoca dorsata*, to its occurrence "in mari Camtschatico praesertim circa Olutora observatur, indeque versus arcticum fretum passim habitat." As his *Phoca dorsata* has been currently synonymized with *Phoca grœnlandica* (as it obviously is in part), the Kamschatkan record has been accredited to *Phoca grœnlandica*. Temminck mentions having seen three skins obtained at "Sitka," but this locality is obviously erroneous.

In writing to Dr. Stejneger, while preparing this paper, I expressed doubt of the occurrence of *Phoca grœnlandica* in the North Pacific or adjacent arctic waters, and asked him to kindly inform me whether Nordquist recorded specimens taken there during the voyage of the 'Vega,' the report on the scientific results of this voyage not being then accessible to me.[1] Under date of November 7, 1902, he says: "His [Nordquist's] only authority for *Ph. grœnlandica* in Kamschatka is the assumption of its identity with Pallas's *Ph. dorsata*, and he adds (p. 106): 'In the Zoöl. Museum of the Academy of Sciences in St. Petersburg there are found a few skulls and skins under the name of *Phoca dorsata* with the statement that they are from Kamschatka. They belong without doubt to females and young males of *Phoca fasciata*. . . . For the present the occurrence of this species in the Pacific seems very improbable.' "

The vicinity of Wrangel Island is of course outside of the geographical limits of the present paper; but Mr. Nelson's observations are of special interest in this connection as extending the known range of *Phoca grœnlandica* far to the eastward of its previous recorded occurrence. Nordquist states that it was not observed on the 'Vega' Expedition east of White Island, near the mouth of the Gulf of Obi,

[1] Through the kindness of Dr. Stejneger I have been able, since this matter was put in type, to consult Nordquist's Report.

although the region to the eastward was traversed and the 'Vega' wintered off the northeast coast of Siberia.

Although there is no satisfactory evidence of the occurrence of *Phoca grœnlandica* in the North Pacific nor in Bering Sea, the species is included partly for the reason of its previous records from this region, and partly for the purpose of calling attention to the unsatisfactory evidence of its claim to a place in the list of North Pacific seals.

4. **Phoca (Pusa) hispida** (*Schreber*).[1]

RINGED SEAL.

Phoca fœtida NORDQUIST, Vega-Exped. Vetensk. Iakt. II, 1883, 104 (Bering Island).—MURDOCH, Rep. Point Barrow Exped. 1885, 95 (Point Barrow). — NELSON & TRUE, Rep. Nat. Hist. Coll. Alaska, 1887, 261 (Unalakleet and St. Michaels, Alaska). — STEJNEGER, Bull. U. S. Fish Comm. XVI, 1896, 21 (Commander Islands). — STONE, Proc. Acad. Nat. Sci. Phila. 1900, 44 (Point Barrow).

This species is abundantly represented in collections from Point Barrow, where it is reported by Murdoch as common at all seasons. Stone records 28 specimens (skulls) as collected there by the McIlhenny expedition. There are also specimens in the U. S. National Museum from St. Michaels, Alaska, and Plover Bay, Siberia, and Stejneger has recorded it from the Commander Islands. Specimens were collected for the American Museum by Mr. Buxton in the Okhotsk Sea, which differ in smaller size and weaker dentition from the Point Barrow specimens, and seem to represent a recognizable subspecies, described below. The Point Barrow specimens, collected by McIlhenny, which, through the kindness of the authorities of the Wistar Institute of Philadelphia, I have been able to examine, agree well with nearly as many Greenland (Davis Strait and Baffin Bay) specimens in the American Museum.

Phoca hispida presents a wide range of purely individual variation in the size and the structure of the teeth. The teeth vary in size in different specimens of the same sex from the same locality by fifty per cent, the teeth in some speci-

[1] *Phoca hispida* Schreber (pl. lxxxvi, 1775) has one year priority over *Phoca fœtida* Fabricius (O. F. Müller's Zool. Dan. Prod., p. viii, 1776).

mens being twice as heavy as in others. An equally noteworthy variation is seen in the number of cusps on the teeth of the premolar-molar series. In the upper teeth pm^1 has usually two cusps, but sometimes three. The other teeth have usually three cusps, but pm^2 and pm^3 have often only two, the anterior cusp being wholly suppressed; quite as often pm^2 or pm^3, or both, have four cusps, through the development of an anterior cusp and of two posterior cusps. Frequently the corresponding teeth on the two sides of the jaw vary in the number of cusps. While the difference is not sexual, extra cusps appear to be more frequently developed in the male than in the female.

In the lower teeth pm_1 and the molar usually have three cusps each, and pm_{2-4} have usually four each. The lower molar is of special interest in comparison with the lower molar in *P. vitulina*, *P. richardii*, and *P. ochotensis*, in which the number of cusps varies from three to four. In *Phoca hispida* in about 33 per cent of the skulls the molar has four cusps, and in the other 66 per cent only three cusps. In about 12 per cent the molar on one side of the jaw has three cusps and on the opposite side four cusps. The difference is not sexual, since males and females occur in both series.

5. **Phoca (Pusa) hispida gichigensis,** subsp. nov.

OKHOTSK SEA RINGED SEAL.

Type, No. 18276, ♀, young adult, Gichiga, Okhotsk Sea, Oct. 12, 1900; N. G. Buxton, Jesup North Pacific Expedition.

Similar to *P. hispida*, but very much smaller, and with relatively weaker dentition.

This subspecies is represented by two skins and their skulls, both young females, taken at Gichiga, on the western coast of the Okhotsk Sea. One of the skulls is complete; the other consists of only the lower jaw and the rostral portion of the skull, including the complete dentition.

The external measurements of one of the specimens (No. 18277) are as follows: Total length, 770 mm.; tail, 90; hind foot, 190. The other specimen, of which apparently no measurements were taken, is somewhat larger.

The type skull measures as follows: Basal length, 139 mm.; greatest zygomatic breadth, 86; mastoid breadth, 92; front edge of intermaxillæ to pterygoid hamuli, 75; front border of incisors to posterior border of

molar, 42; front of intermaxillæ to meatus auditorius, 96; palatal length (on median line), 58; palato-maxillary suture to anterior border of foramen magnum, 86; palatal width between the molars, 27.5; length of upper premolar-molar series, 29; length of nasals, 35; breadth of nasals at middle, 5.5; least interorbital breadth, 7; length of brain-case, 65; greatest width of brain-case, 82; length of lower jaw, 86; length of lower premolar-molar series, 30.

The skins have lain saturated with oil for nearly two years, and doubtless the general color has thereby been more or less altered. The upper surface is now yellowish brown, the sides and back inconspicuously marbled with dark brown or blackish; the spots are irregular in size and shape, and are often confluent. The ventral surface is yellowish white, wholly unspotted.

The small spotted seal of Bering Sea has commonly been referred to *Phoca hispida*. I have had before me some 30 or more skulls from Bering Sea and adjacent waters (5 from St. Michaels, 1 from Unalakleet, 1 from Port Clarence, 1 from Point Barrow, and 3 from Plover Bay, Siberia) which present no tangible differences from a large series from Greenland. On the other hand, the two female skulls from Gichiga are notably smaller, with relatively much weaker dentition. A larger series from the Okhotsk Sea might bridge over the difference in size, but there are strongly marked differences in other features. Although there is a wide range of individual variation in size among female skulls of *Phoca hispida*, I find none in the large series now available for examination as small as the two Gichiga skulls, in which the length is 12 to 15 mm. shorter than in average specimens of *P. hispida*.

More important differences consist in the much weaker dentition, and in the relative length of the premaxillary portion of the palatal floor and the correlated differences in the length and shape of the anterior palatine foramina. The upper toothrow is about one-tenth shorter than in the smallest Greenland and Bering Sea examples, and the teeth themselves are more than correspondingly less robust than this difference would necessarily imply, the teeth being very narrow in their transverse breadth and hence far more delicate in general size and structure.

The anterior palatine foramina are relatively much shorter and broader than in *P. hispida*, with a quite different contour,

shown especially in the more shallow hollowing of their anterior portion. Their shortness is due to the shortness of the premaxillary portion of the palate, which is one-fifth shorter than in *P. hispida*. In view of these differences the Okhotsk Sea form seems well entitled to subspecific recognition.

6. **Phoca ochotensis** *Pallas.*

OKHOTSK SEAL.

Figs. 5–6.

Phoca ochotensis PALLAS, Zoog. Rosso-Asiat. I, 1811, 117 (Okhotsk Sea).

Type of present description, No. 18169, ♀ ad., mouth of Gichiga River, Okhotsk Sea, Aug. 17, 1901; N. G. Buxton, Jesup North Pacific Expedition.

General color above yellowish olive-brown, profusely marked with small, irregular, dark brown and blackish spots, most numerous and largest over the median area; below yellowish or ochraceous brown, with fewer and more sharply defined spots of black. Tail dark above and much spotted, lighter and unspotted on the sides and below. Upper surface of feet heavily spotted, the lower surface without spots. Whiskers white, crenulate for the basal third, the apical portion straight and smooth; longest whiskers 75–90 mm. in length. Nails dark brown or blackish, long and narrow. The digits of the manus recede in length from the 1st to the 5th, the front border of the manus being much less square than in *Phoca vitulina* and *P. stejnegeri*. There seems to be no sexual difference in color and very little in size.

Measurements. — Total length, 1470 mm.; tail, 130; hind foot, 265. Two other males and a female range in total length from 1340 (female) to 1470 (male) mm.

Skull. — The skull is long and narrow in proportion to its breadth, with the rostral portion greatly attenuated in comparison with any of its allies, perhaps most resembling in general outline that of *Phoca grœnlandica*. The audital bullæ are very large and greatly inflated, the portion forming the meatus auditorius much produced and sharply constricted from the bulla, as in *Phoca grœnlandica*. The premaxillæ are in contact with the nasals for a short distance, and the frontals extend further forward along the nasals then in *P. vitulina*. The dentition differs strikingly from that of any of the allied species, the teeth being intermediate in stoutness between those of *P. grœnlandica* and *P. vitulina*, stand in a straight line, and are separated by well-marked diastema. The upper premolar-molar series are all bicuspid; there is a high main cusp, with the point curved backward, and a small accessory cusp behind it; in front of the main cusp the cingulum is strongly beaded, with, in some specimens, an incipient cusp. There is a similar tendency to the

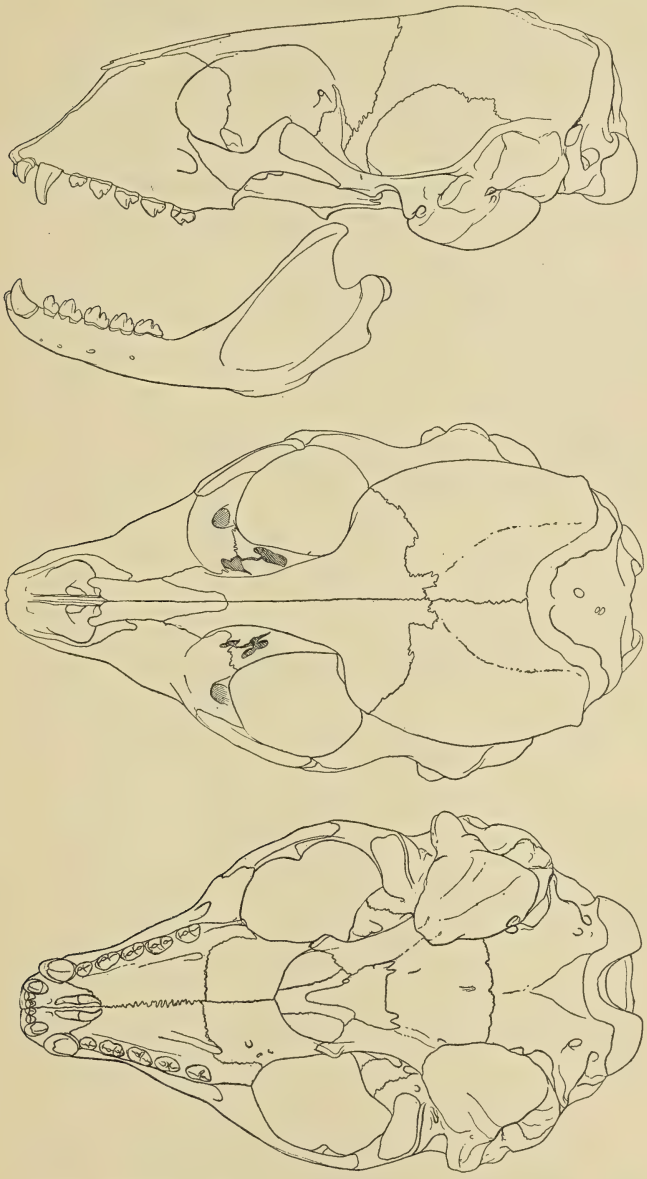

Fig. 5. *Phoca ochotensis.* Type of present description. Am. Mus. No. 18169, ♀ ad., Okhotsk Sea. Lateral, superior, and palatal views of skull. $\frac{2}{3}$ nat. size.

development of a minute cusp behind the secondary cusp, especially on pm^3 and pm^4. The posterior three lower teeth are generally 4-cusped.

The same irregularity in the number of cusps, already mentioned as occuring in *Phoca vitulina* and *P. richardii*, is found in *P. ochotensis*. The lower molar, however, appears to be pretty uniformly 4-cusped, with quite frequently an 'adventitious' cusp at the postero-inner base of the main cusp.

The only complete skull is that of the type, an adult female, which measures as follows: Basal length, 200 mm.; greatest zygomatic breadth, 114; mastoid breadth, 117; front border of premaxillæ to pterygoid hamuli, 105; front-border of upper incisors to posterior border of upper molar, 67; front border of premaxillæ to meatus auditorius, 142; palatal length (along median line), 78; palato-maxillary suture to pterygoid hamuli, 44; palato-maxillary suture to interior border of foramen magnum, 130; palatal width between the molars, 42; length of upper toothrow, 45; length of nasals, 43; breadth of nasals at fronto-maxillary suture, 12; least interobital breadth, 14; length of brain-case, 85; greatest width of brain-case, 91; length of lower jaw, 129; lower toothrow, 46. The male skulls are imperfect; the parts preserved include the frontal portions, with the complete dentition, and indicate that the males are somewhat larger than the females, with rather heavier teeth.

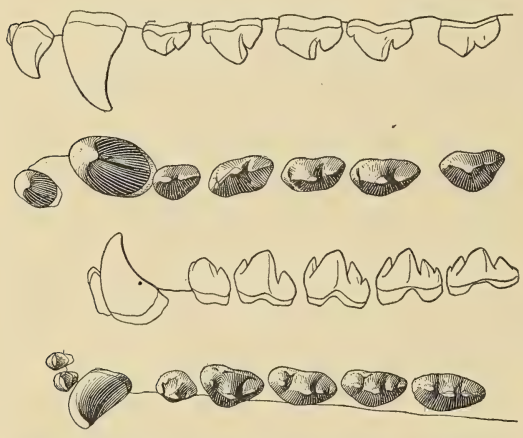

Fig. 6. *Phoca ochotensis*. Am. Mus. No. 18169. Outside and crown views of upper and lower teeth. Nat. size.

This species is represented by five specimens (skins and skulls), collected by Mr. N. G. Buxton on the Taiganose Peninsula, 20 miles south of the mouth of the Gichiga River, August 17 and 18, and September 4, 1901.

In cranial and dental characters *Phoca ochotensis* is intermediate between *Phoca vitulina* and *P. grœnlandica*, but is widely distinct from either. Subgenerically it is a *Phoca* and

not a *Pagophilus*, lacking the flattened frontal region, the square palatal border, and extensively ossified narial septum of the latter, while the dentition is considerably heavier. In general form the skull is much more elongated and relatively much narrower than in *Phoca vitulina*, with markedly weaker dentition.

Pallas gave the name *Phoca ochotensis* to a small spotted seal found in the Okhotsk Sea, which he says was especially abundant between "Tanisk" and "Ishiga" (= Tansk and Gichiga of modern maps). His long description is not especially diagnostic, but seems to point to the present species, particularly in his reference to its slenderer and more graceful form as compared with its congeners. His description of the under parts as "subtus maculis subquadratis sparsis, obsolete testaceis, sub collo crebrioribus," is characteristic of the present species in contradistinction to *Phoca hispida gichigensis*, the only other form of *Phoca* known from the Okhotsk Sea. A definite type locality is given by Pallas, at which the present specimens were taken, and which are therefore topotypes. His statement "auriculæ externæ minutæ nigricantes" might seem to indicate an eared seal, but the whole tenor of his description shows conclusively that his *Phoca ochotensis* is a species of *Phoca*.[1] Besides, a minute blackish rim around the ear opening is distinguishable in the present specimens, and in one is quite noticeable. It is doubtless this to which he refers in describing the ear.

7. **Phoca ochotensis macrodens,** subsp. nov.

SIBERIAN SEAL.

Phoca largha STONE, Proc. Acad. Nat. Sci. Phila. 1900, 43 (Point Barrow, Alaska). Not *Phoca largha* of Stejneger, True, and others as applied to specimens from Bering Island, Pribilof Islands, etc.

Type, No. 83447, U. S. Nat. Mus., young adult (♂), Avatcha Bay, Kamschatka, 1896; Dr. L. Stejneger.

Similar in dental and cranial characters to *Phoca ochotensis* but with much heavier dentition, and the teeth less separated, especially in the lower jaw. The external characters are not known.

Skull. — Similar in general conformation to that of *Phoca ochotensis*,

[1] That he knew the eared seals is shown by his description of his *Phoca leonina* (= *Eumetopias jubata* = *E. stelleri* auct.) and *Phoca nigra*, which latter is based primarily on a young fur seal from the Kurile Islands, recently named *Callorhinus kurilensis*, but which must apparently be called *Callotaria nigra*.

the rostral portion of the skull being similiarly narrow and elongated in comparison with the other species of *Phoca*. The type skull, which is apparently that of a 'young adult' male, measures as follows: Basal length, 205 mm.; greatest zygomatic breadth, 112; mastoid breadth, 117; front border of premaxillæ to pterygoid hamuli, 106; front border of upper incisors to posterior border of upper molar, 61; front border of premaxillæ to meatus auditorius, 143; palatal length (along median line), 78; palato-maxillary suture to pterygoid hamuli, 44; palato-maxillary suture to anterior border of foramen magnum, 128; palatal width between the molars, 39; length of upper toothrow, 43.5; length of nasals, 45; breadth of nasals at fronto-maxillary suture, 11; least interorbital breadth, 11; length of brain-case, 85; greatest width of brain-case, 93; length of lower jaw, 128; lower toothrow, 43. An adult skull, apparently female, is smaller, the principal dimensions being as follows: Basal length, 182; zygomatic breadth, 102; mastoid breadth, 106; front border of premaxillæ to pterygoid hamuli, 94; front border of premaxillæ to meatus auditorius, 128; palatal length (along median line), 70; palato-maxillary suture to foramen magnum, 115; palatal width between molars, 35; length of upper toothrow, 40; length of nasals, 37; width of nasals at fronto-maxillary suture, 9; length of lower jaw, 112; lower toothrow, 38.5.

This form ranges from the southeastern coast of Kamschatka north to Point Barrow, Alaska, and is represented by the following specimens, which are skulls only: Avatcha Bay, Kams., Nos. 83447 and 83448, U. S. Nat. Mus., apparently male and female, both adult but not old, collected by Dr. Stejneger in 1896; Plover Bay, Siberian side of Bering Strait, No. 6783, U. S. Nat. Mus. (formerly; now No. 6970, Mus. Comp. Zoölogy), collected by Col. Buckley; Point Barrow, Alaska, No. 16761, U. S. Nat. Mus., apparently ♀, collected by John Murdoch. Also three skulls, all collected by the E. A. McIlhenny Expedition (orig. Nos. 22 and 30, Acad. Nat. Sci., Philadelphia, and No. 5390, Wistar Institute, Philadelphia), and all labelled as female by the collector. Detailed measurements are given of all these skulls in the table on p. 497.

Phoca ochotensis macrodens differs from *P. ochotensis*, so far as the skulls are concerned, in the much greater size of the teeth, which, while the toothrow is of the same length in both, are much larger and stand closer together, leaving much smaller diastema between those of the upper jaw, while in the lower jaw they are in close contact, and sometimes crowded, so that pm_2 is generally, and pm_3 is sometimes inserted

obliquely to the axis of the toothrow. The mandibular series thus closely resembles the teeth of the more delicate females of *Phoca richardii* and *P. vitulina*.

In this connection the Plover Bay skull is to me of special interest. It is a large and apparently very old male, which in 1880 (Hist. N. Am. Pinnipeds, pp. 572 and 579) I referred provisionally to *Phoca vitulina*, with the following comment: "My attention has been forcibly drawn to this matter [sexual variation] by a skull (No. 6783, Nat. Mus.) from Plover Bay (Siberian Coast of Behring's Straits), which I at first referred unhesitatingly to *Phoca vitulina*, when examined in connection with a large series from both the Atlantic and Pacific coasts of America, but later, when compared again with a smaller series, I thought it might represent a form closely allied to, but still specifically distinct from, *P. vitulina*—probably the so-called *Phoca 'nummularis.'* On collating it again with the full series first examined it seemed undoubtedly to be only an old female of *P. vitulina*. Aside from the slighter and more delicate structure of the skull, the most notable differences are the smaller, normally implanted, and even slightly spaced molar teeth, the narrowness of the facial portion of the skull, and the corresponding narrowness of the lower jaw and absence of the abrupt outward curvature of the rami at the last molar . . ." (*l. c.*, p. 572). This extract is here quoted as showing the chief points of difference between *Phoca vitulina* and *Phoca ochotensis* and its subspecies *macrodens*. This Plover Bay skull I now regard as an old male *P. ochotensis macrodens*, instead of a female *Phoca 'vitulina'* with exceptionally weak dentition and delicately developed skull. In other words, as regards dentition, there is a resemblance in the size and position of the teeth between males of *P. ochotensis* and females of *P. vitulina*.

8. **Phoca stejnegeri**, sp. nov.

BERING ISLAND SEAL.

Figs. 7–10.

Phoca largha STEJNEGER, Bull. U. S. Fish Comm. XVI, 1896, 21 (Commander Islands). No description. Not *Phoca largha* Pallas, sp. indet.

Type, Nat. Mus. No. 21310, ♂ ad., skull, Bering Island, April 16, 1883; Dr. L. Stejneger.

Similar in general features to *Phoca vitulina*, but much larger, and differing essentially in cranial and dental characters.

Light Phase. — Above deep straw yellow, profusely marked with very small sharply defined black spots, most numerous on the back, from the nose to the tail; ventral surface more sparsely spotted and general color deeper yellow. Whiskers yellowish brown, perhaps from staining, flattened, nodular for the basal half, the apical portion smooth, the longest about 90–100 mm. in length. Nails brownish black, rather short and stout. Those on the anterior digits range in length from 27 mm. on the 5th to 37 on the 1st; on the posterior digits the nails are too imperfect for measurement. The fore flippers are rather truncated, being less pointed than in *P. ochotensis*, the end of the 5th reaching to within 25–30 mm. of the end of the 1st, as against 50 mm. in *P. ochotensis*.

Dark Phase. — General ground color as in the light phase, but almost obliterated by the profuseness of the dark spots, which occupy about four fifths of the dorsal surface and rather more than one half of the ventral surface. Over the median third of the dorsal region the spots are more or less confluent, and are separated, when distinct, by very narrow, irregular spots and bands of the ground color; on the sides and below the spots are more separated and occupy only about one half of the general surface. On the limbs the dark markings form large patches, interspersed with much smaller areas of the ground color. Although the dark specimen (No. 114652, Tchipunski Bay, southeastern coast of Kamschatka) is a female, the difference is obviously not sexual, as one of the light specimens is also a female.

Young. — A young specimen (No. $\frac{13987}{38013}$, Bering Island), about one fourth grown (830 mm. long), has the ground color lighter than in the light phase of the adults — above yellowish gray profusely spotted with dusky, below pale yellow sparsely marked with dusky spots and blotches. The dark markings are more or less veiled with the lighter ground color and hence less sharply defined and grayish black rather than black, as in the adults. This specimen, though only a few weeks old, is about the size of a full-grown female *Phoca hispida*. The permanent dentition had barely cut the gums.

A fœtal specimen (No. 13990, ♂, Bering Island, March 12, 1883), about 640 mm. long, has the general color pale yellow (white in life ?), with a narrow dorsal brownish band, darkest on the head, lower part of back, and tail; upper surface of fore flippers dusky brown; hind flippers dusky grayish brown on both surfaces, less dark than upper surface of fore flippers.

External Measurements. — The principal external measurements, taken in the flesh by Dr. Stejneger, of four specimens killed on Bering Island and neighboring points on the Kamschatkan coast, are as follows:

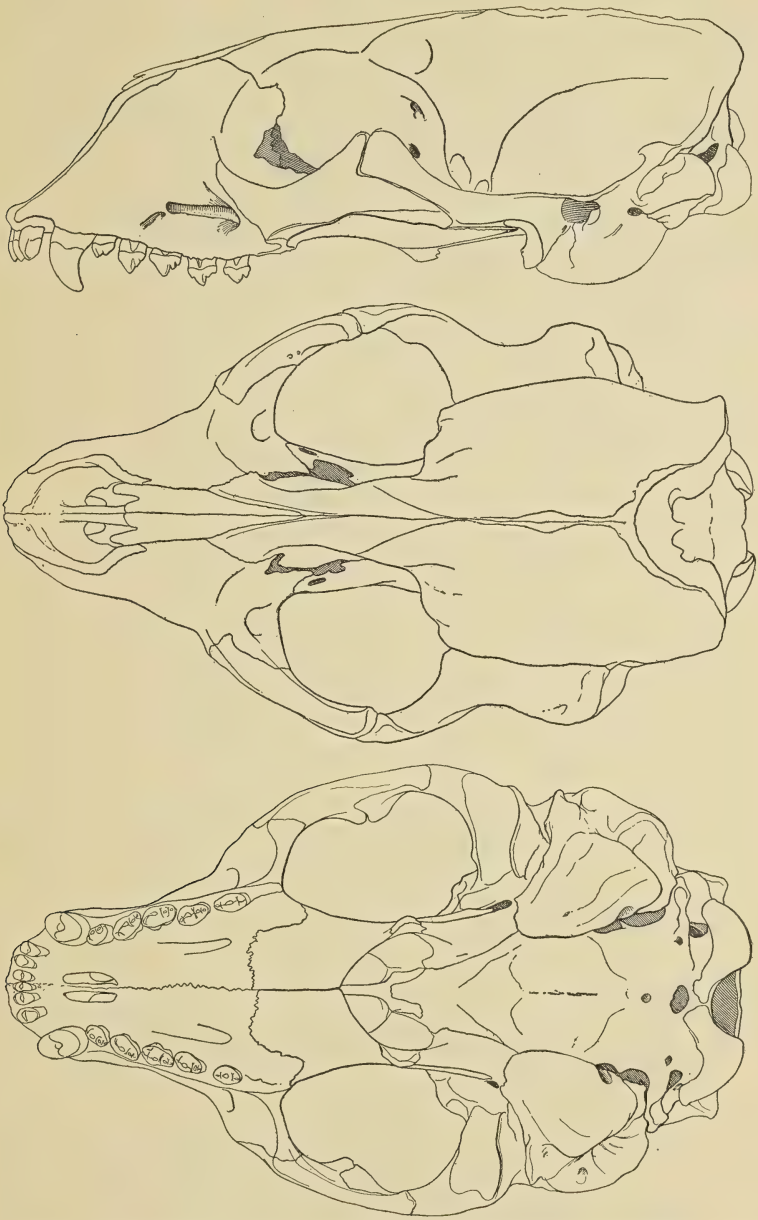

Fig. 7. *Phoca stejnegeri.* Type: No. 21310 U. S. Nat. Mus., old ♂, Bering Island. Lateral, superior, and palatal views of skull. $\frac{2}{3}$ nat. size.

Orig. No. (Dr. Stejneger)	Nat. Mus. No.	Sex.	Length		Tail.	Hind foot.
			Nose to end of tail.	Nose to end of hind flipper.		
2609	13986/38012, Staritshkof Is., Kams.	♂ juv.	1545	1760	140	335
2610	13985/38011, Avatcha Bay, Kams.	♂ juv.	1665	1880	145	350
2767	114652, Tchipunski Bay, Kams.	♀ juv.	1680	1870	135	330
2579	13988/38014, Petropaulski, Kams.	♀ ad.	1850	2190	120	340

Skull. — The skull is fully twice as large as that of *Phoca vitulina*, from which it differs mainly, so far as general features are concerned, in its massiveness. The teeth are essentially the same as in the *P. vitulina* group (*Phoca* restr.), in which the dentition differs from that of the *Pusa* and *Pagophilus* groups in the large size of the crowded and more or less obliquely implanted teeth, the teeth in both *Pusa* and *Pagophilus* being small, placed in a straight line and separated by broad diastema. *P. stejnegeri* agrees with all of the other known Pacific and Bering Sea seals of the genus *Phoca* in the posterior extension of the premaxillæ to the side of the nasals, but differs from them in the possession of a groove in front of the infraorbital foramen for the maxillary nerve, which runs forward from the infraorbital foramen to a point opposite the middle of pm^3. As this deep, strongly defined groove is present in all of the four skulls of *P. stejnegeri* available for examination, and is uniformly absent from some thirty or more skulls of *P. vitulina*, *P. richardii*, and *P. ochotensis*, it appears to be a character of some weight.

Dentition. — Another feature of importance is found in the character of the teeth, the superior premolars 2-4 being 4-cusped in the type skull, and apparently so in the two other adults, in which, however, the teeth are too much worn for satisfactory examination. In the young (female?) skull (No. 21311), these teeth have the same conformation as in *P. vitulina*.[1] In the lower jaw pm_{2-4} are strongly 4-cusped, as is also the molar in two of the three adult skulls; in the third the molar on both sides of the jaw has been lost. In the lower jaw of the young skull pm_{2-4} on both sides, and the molar on the right side, are distinctly 4-cusped, but the molar on the left side has only three cusps. In other words, *P. stejnegeri* seems to be separable from the *P. vitulina* group by the quadricuspid instead of tricuspid superior molariform teeth.

The premolars have the same oblique position as in *P. vitulina*, varying greatly, however, in this respect with the individual. In the three adult skulls from Bering Island only pm^2 is obliquely implanted, but in

[1] The crowns of the teeth in the skulls Nos. 38011–38013 and No. 114652 have crumbled away, and these skulls therefore throw no light on the number of cusps and form of the teeth.

the young skull both pm^2 and pm^3 are set obliquely. In another very young skull (No. 38013) from Bering Island, pm^2 is strongly oblique and pm^3 is slightly oblique. In No. 114652, a young female, pm^2 on the left side is oblique, but the corresponding tooth on the right side, and all of the other premolars on both sides stand in a straight line. In No. 38011, a young adult male, from Avatcha Bay, all the upper premolars are set obliquely, while in No. 38012, also a young adult male, only pm^2, on both sides, is set obliquely, all the other teeth standing parallel to the axis of the toothrow. In No. 38014, a female from Petropaulski, all of the teeth in both jaws are set in straight lines. Thus in the maxillary series pm^2 is always strongly oblique to the toothrow, and pm^2 more or less so in male skulls, while only pm^2, and this apparently rarely, is placed obliquely in the female.

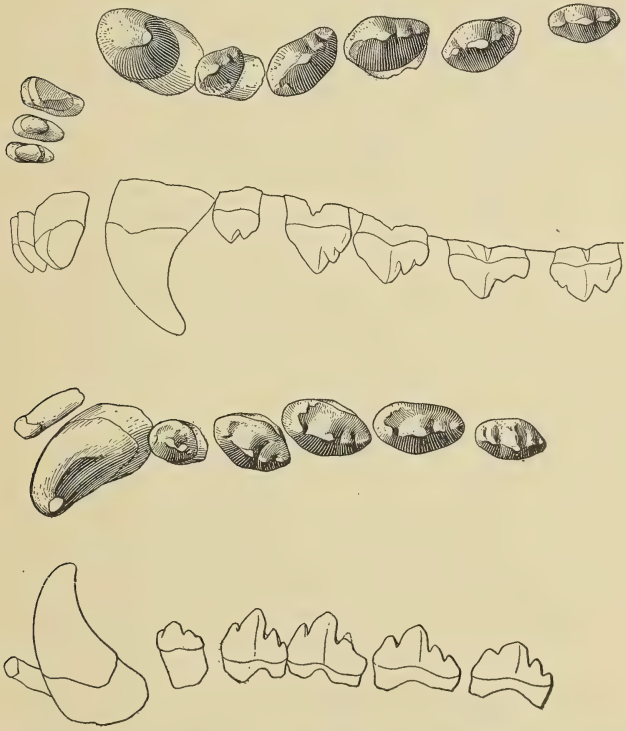

Fig. 8. *Phoca stejnegeri.* Type: U. S. Nat. Mus. No. 21310, old male. Crown and outside views of upper and lower teeth. Nat. size.

In the lower toothrow pm_2 and pm_3 and sometimes pm_4 have a position strongly oblique to the axis of the toothrow in both sexes, especially

pm_2 and pm_3, but the amount of obliquity is rather less in the female, and in one specimen (No. 38014) all of the lower premolars stand parallel to the axis of the toothrow.

Fig. 9. *Phoca stejnegeri*, very young ♀ (?). U. S. Nat. Mus. No. 21311. Bering Island. Lower molars; the right lower molar in this specimen has four cusps, the left only three. Nat. size.

Measurements (type skull).—Basal length, 248 mm.; greatest zyogmatic breadth, 150; mastoid breadth, 139; front border of premaxillæ to pterygoid hamuli, 134; front border of upper incisors to posterior border of upper molar, 80; front border of premaxillæ to meatus auditorius, 235; palatal length (along median line), 103; palato-maxillary suture to pterygoid hamuli, 49; palato-maxillary suture to anterior border of foramen magnum, 148; palatal width between the molars, 50; length of upper toothrow, 52; length of nasals, 61; breadth of nasals at fronto-maxillary suture, 15; least interorbital breadth, 17; length of brain case, 91; greatest width of brain case, 100; length of upper jaw, 158; length of lower toothrow, 50.

Five additional skulls are available for measurement as regards the principal dimensions which, with the corresponding measurements of the type, may be tabulated as follows:

Nat. Mus. No.	Sex and age.	Locality.	Basal length.	Zygomatic breadth	Mastoid breadth
21310[1]	♂ very old.	Bering Island.....	248	150	139
21311	juv.	" "	190	118	118
21312	very old.	" "	225	145	127
21335	♀ ? very old.	" "	222	118	——
38012	♂ juv.	Staritshof Isl., Kams.....	230	126	137
38011	♂ "	Avatcha Bay, Kams.....	228	137	136

The skulls of Nos. 38011 and 38012 have not been cleaned, and the teeth have suffered much injury from long immersion (with the skins) in a preservative solution, but it is evident that both specimens are merely 'young adults' which had not attained their full size.

Phoca stejnegeri is a member of the *P. vitulina* group, from other forms of which it differs by its much larger size (see fig. 10, p. 494, for relative size of bullæ), and in certain well-marked characters of the skull and teeth, as already detailed. It is doubtless as variable in coloration as is *Phoca richardii* and *P. vitulina*[2], at least in some of its phases.

[1] Type.

[2] On the color variations of *Phoca vitulina cf.* Allen, Hist. N. Am. Pinnipeds, 1880, pp. 562–564.

This very distinct species is represented by four skulls from Bering Island, one of which is labeled male, but the sex of the others is not designated. Three of the skulls are very old and massive, especially the one marked male, and the other is very young, probably a yearling. In addition to these four skulls there are six skins, five of which have skulls, representing four 'young adults' (two males and two females), a fœtal specimen (without skull), and a young specimen, probably a month to six weeks old. The skins, with their skulls, have lain for eighteen years in a vat of preservative fluid (Hornaday solution); the skins on being removed from 'pickle' and prepared for examination are in fair condition, though possibly the ground color is a little discolored from staining; the skulls, however, have greatly deteriorated from the action of the solution, the bones having become softened from loss of calcareous matter, and the teeth have mostly crumbled off down to the alveoli. There is enough left of them to show their manner of insertion, and two of the skulls are susceptible of measurement as regards their general proportions; the other three are imperfect, only the rostral portion and the lower jaws being preserved. The two young specimens are from Bering Island, the adults from localities on the neighboring coast of Kamschatka,—one each being from Petropaulski, Staritshof Island, and Avatcha and Tchipunski Bays. They were all collected by Dr. Leonhard Stejneger in 1883, and of the specimens represented by skins, detailed measurements were taken by him from the fresh specimens, and form a part of the material of the present investigation. It therefore gives me great pleasure to connect his name with this fine large seal, as a slight recognition of his invaluable contributions to the natural history of the Commander Islands and neighboring regions.

9. **Phoca richardii** *Gray.*

Pacific Harbor Seal.

Halicyon richardii Gray, P. Z. S. 1864, 28, fig. 1, skull (Vancouver Island); Cat. Seals and Whales, 1866, 30, fig. 9; Hand-list Seals and Whales, 1874, 4. — Gill, Proc. Essex Inst., V, 1866, 13 (ex Gray).

[*Phoca*] *richardsi* SCLATER, P. Z. S. 1873, 556, footnote (emendation of name).—ALLEN, Bull. Am. Mus. Nat. Hist. XVI, 1902, 225 (Alaska Peninsula).

Phoca pealii GILL, Proc. Essex Inst. V, 1866, 13 ("California and Oregon"). Not *Phoca pealii* Gill, *ibid.*, p. 4, footnote = *Halichœrus antarcticus* Peale.

Phoca pealii? SCAMMON, Marine Mamm. 1874, 164, pl. xxii, animal.

Phoca vitulina CLARK, P. Z. S. 1873, 556 (on Gray's type specimen of *Halicyon richardii*).—ALLEN, Hist. N. Am. Pinnipeds, 1880, 559, in part (Pacific Coast references only).—ELLIOTT, Seal Islands of Alaska, 1882, 28, pl. iv, in part (Pribilof Islands).—NELSON & TRUE, Rep. Nat. Hist. Coll. Alaska, 1887, 264, in part (St. Michaels, mainly).

Phoca vitulina var. *largha* NORDQUIST, Vega-Exped. Vetensk. Iakt. II, 1883, 102 (reference to skulls from Unalashka in the St. Petersburg Zoölogical Museum).

Phoca largha? TRUE, in Jordan's Rep. Fur-Seal Islands, Part III, 1899, 351 (Pribilof Islands).

The only specimens available for examination from anywhere near the type locality are two skulls from Puget Sound (Nat. Mus. Nos. 6535 and 6159), one of them badly broken, and another (Nat. Mus. No. 6486) from "Washington Territory," the two latter quite young, and all unmarked as to sex. Judging by the size and shape of the teeth the two young specimens are both females, and agree closely in every respect with specimens from the New England coast of corresponding age and known to be females, except in the single character of the greater posterior extension of the premaxillæ so as to touch the nasals.

Another skull from Yakutat Bay, Alaska (Nat. Mus. No. 98139), slightly older and unmarked for sex, is also similar; the dentition is weak but the lower molar is distinctly 4-cusped. A young skull from Kenai, Alaska (Nat. Mus. No. 9480) is like the two skulls from the Puget Sound region. Another skull from Adakh Island, Alaska (Nat. Mus. No. 14399), is very young and probably a male, pm2 and pm3, both above and below, being set very obliquely, and the lower molar being strongly 4-cusped.

Next in geographical sequence are four very young skulls from St. Michaels, Alaska (Nat. Mus. Nos. 21474–21477). Three of them appear to be females, the dentition being light

and the lower molar 3-cusped. The fourth (No. 21476) has the teeth heavier, much more crowded, and the lower molar is 4-cusped.

There is nothing to suggest, in view of the normal variability of the skulls and teeth in this and allied groups of seals, that the above enumerated ten skulls are not all referable to the same species. They are all 'young adults,' except the broken Puget Sound skull and the Yakutat specimen, which are adult, but not old.

In addition to the above are three skulls from the Pribilof Islands (Nat. Mus. Nos. 15276, 49550, 101330). The latter is much the younger and seems to be a female, on the basis of its light structure, small and non-obliquely set teeth, but the lower molar is strongly 4-cusped, a feature more commonly found in the male. Skull No. 49550 is larger and also much older, with the teeth heavier and more crowded, and the lower molar is tricuspid. No. 15276 is a very old skull (without lower jaw), and the teeth are very much worn, little but the roots being left. Its general appearance indicates it to be an extremely old male. The teeth, however, all stand in a straight line.

No. 6157 (Mus. Comp. Zoöl.), from Santa Barbara Islands, California, is an exceedingly old, heavily ossified skull, almost beyond question male. The teeth are exceedingly heavy and very little worn; pm2 and pm3 are very obliquely set in both jaws; the lower molar is distinctly 4-cusped on the left side and indistinctly so on the right side. Compared with No. 15276 from Pribilof Islands, it is more heavily ossified, the teeth are much larger, and pm2 and pm3 much more obliquely set; the teeth are not much worn, while in the Pribilof skull they are exceedingly worn.

As these pages are passing through the press I have received from Dr. C. Hart Merriam, Chief of the Biological Survey of the U. S. Department of Agriculture, four adult skulls—two male and two female—of *Phoca* collected at San Geronimo Island, off northern Lower California, by Mr. A. W. Anthony, in September, 1896, for the Biological Survey. These skulls agree closely with the Santa Barbara skull above

described in their large size and heavy dentition in comparison with true *Phoca richardii* from further north, and with the Pribilof Islands skulls. They present no other very appreciable differences than greater massiveness in general structure and dentition. The lower molar is 3-cusped in both rami of one of the males, and faintly 4-cusped on the left side and 3-cusped on the right side in the other; in one of the females the lower molar is 4-cusped in both rami, and in the other 4-cusped on the right side and 3-cusped on the left side—showing, if further evidence were needed, that the variation in the number of cusps in the lower molar is a feature merely of individual variation and not a sexual, and much less a specific character.

Phoca richardii differs from *Phoca vitulina* from the east coast (= *P. concolor* Dekay) of North America only in the slightly greater posterior prolongation of the premaxillæ, giving them a slightly more extended contact with the nasals; this feature, while somewhat variable, will suffice to distinguish the two forms at a glance. In the general conformation of the skull and in dentition the two forms are indistinguishable.

Phoca richardii differs from *Phoca stejnegeri* through the much smaller size and much less massive character of the skull, as shown in the table of measurements (p. 498), where, in a note to the table, attention is called to strictly comparable specimens of the two forms. The auditory bullæ, for example, in No. 21311, from Bering Island, a very young skull with all the sutures open, are twice the size of the auditory bullæ in No. 15276, from the Pribilof Islands, a very old skull with the crowns of the teeth almost wholly worn away. *Phoca ochotensis* has a skull so much slighter in structure and so different in proportions and dentition from *P. richardii* that no comparison of the two is necessary.

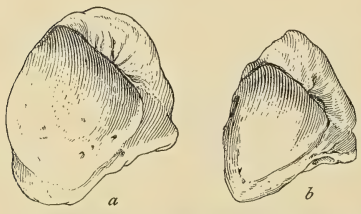

Fig. 10. Comparative views of right audital bulla of *Phoca stejnegeri* and *Phoca richardii*. *a*, *P. stejnegeri*, U. S. Nat. Mus. No. 21311, young female (?), probably less than a year old; *b*, *P. richardii*, U. S. Nat. Mus. No. 6486, a 'young adult' female.

10. **Phoca richardii pribilofensis,** subsp. nov.

PRIBILOF HARBOR SEAL.

Phoca largha ? TRUE, in Jordan's Rep. Fur-seal Islands, Part III, 1899, 351 (Pribilof Islands).

Type, Nat. Mus. No. 49550, ♀ (?) ad., Pribilof Islands, Alaska; C. H. Townsend.

The material now at hand affords a rather meager basis for separating the *Phoca richardii* group into subspecies, although its range extends from northern Lower California to the Pribilof Islands. Old skulls, comparable as to age, from the extreme points differ notably in the size of the teeth. As far as the present material goes the dentition appears to be decidedly and uniformly weaker in Alaska specimens than in those from the Puget Sound region, the type locality of *Phoca richardii*, and the northern form may without doubt be properly recognized subspecifically, on the basis especially of the Pribilof Island skulls.

An adult female skin (Nat. Mus. No. 82223), from St. Paul Island, collected by Mr. C. H. Townsend, has the under surface pale ochraceous, varied with paler streaks, and blotched rather indistinctly with dusky, the spots blacker and more distinct on the throat and sides of the neck; sides paler and more heavily and sharply blotched with blackish. The general color of the dorsal surface is silvery yellowish white, profusely marked with dark brown and blackish, the spots confluent over much of the median dorsal area, especially from the top of the head posteriorly to the middle of the back, over which extensive area the general color is blackish. This coloration, however, is not distinctive, as I have seen quite similar specimens from the Santa Barbara Islands.

11. **Phoca richardii geronimensis,** subsp. nov.

SAN GERONIMO HARBOR SEAL.

Type, U. S. Nat. Mus. No. 81520, ♂ ad., San Geronimo Island, Lower California, Sept. 13, 1896; A. W. Anthony.

The Lower California and Santa Barbara Islands form, so far as at present represented, is larger than the Pribilof

Island seal, with the dentition heavier than even that of Puget Sound specimens. In the material now in hand it is represented by a single skull (Mus. Comp. Zoöl. No. 6157), and a stuffed specimen (in the American museum), mounted with the mouth open, displaying the teeth, and by the four San Geronimo Island skulls. That these represent a well-marked subspecies there can be little doubt, characterized by large size and heavy dentition.

The table of measurements of 12 skulls of *Phoca 'vitulina'* (p. 499) from the eastern coast of North America is added for comparison with the Pacific Coast and Bering Sea skulls, from which it will be seen how closely the Atlantic coast skulls parallel those of the *Phoca richardii* group in general size and proportions, and also in details. The large size of the few Greenland specimens is also noteworthy in comparison with those from the New England coast. The first five given in the table are strictly comparable as to age. Most of the New England skulls, however, are young adults. Much more material will doubtless soon be available from the Atlantic coast, when it will be possible to study more satisfactorily this group of Harbor Seals.

MEASUREMENTS OF SKULLS OF *PHOCA OCHOTENSIS*, AND *P. O. MACRODENS*.

	Mus. No.	Sex and Age.	Locality.	Basal length.	Zygom. breadth.	Mastoid breadth.	Front bord. of premax. to pteryg. hamuli.	Front border incisors to post. border molar.	Front bord. premax. to meatus audit.	Palatal length on median line.	Palato-max. suture to foramen mag.	Palatal width between molars.	Length of upper tooth-row.	Length of nasals.	Least interorbital breadth.	Length of brain-case.	Greatest width of brain-case.	Length of lower jaw.	Length of lower toothrow.
Phoca ochotensis	18169 A[1]	♀ ad.!	Okhotsk Sea	200	114	117	105	67	142	78	130	42	45	43	9	85	91	129	—
	18172 A	♂ juv.!	" "	—	—	—	100	59	—	75	—	38	43	40	9	—	—	122	40
	18170 A	♂ juv.!	" "	—	—	—	—	65	—	—	—	—	44	—	—	—	—	129	43
P. o. macrodens.	83447 N[2]	♂ yg. ad.	Avatcha Bay	205	112	117	106	61	143	78	128	39	43.5	45	11	85	93	128	43
	83448 N	♀ ad.	" "	182	102	106	94	57	128	70	115	35	40	37	11	76	86	112	38.5
	6783 N	♂ ad.	Plover Bay, Siberia	213	108	123	106	67	143	78	130	41	46	47	11	85	96	—	—
	16761 N	♀ ad.	Point Barrow, Alaska	195	109	117	104	61	140	81	124	36	43	41	11	79	86	—	—
	5390 N	♀ ad.	" " "	—	115	—	—	—	—	84	—	44	45	46	12	—	—	134	43
	22 P	♀ ad.!	" " "	183	105	—	93	58	128	71	115	36	42	41	10.5	81	93	108	40
	30 P	♀ ad.!	" " "	198	100	106	90	56	123	68	113	35	39	38	11	73	88	111	38.5

[1] Type of present description of *Phoca ochotensis*.

[2] Type of *Phoca ochotensis macrodens*.

A = Am. Mus. Nat. Hist. N = Nat. Mus. P. = Acad. Nat. Sci. Phila

MEASUREMENTS OF SKULLS OF *PHOCA RICHARDII* AND *P. STEJNEGERI*.

	Nat. Mus. Mus. No.	Sex and Age.	Locality.	Basal length.	Zygomatic breadth.	Mastoid breadth.	Front border of premax. to pterygoid hamuli.	Front border of incisors to post. border molar.	Front border of premax. to meatus auditi.	Palatal length on median line.	Palato-max. suture to foramen mag.	Breadth of rostrum at canines.	Palatal width between molars.	Length of upper tooth-row.	Length of nasals.	Least interorbital breadth.	Greatest width of brain-case.	Length of brain-case.	Length of lower jaw.	Length of lower tooth-row.
Phoca richardii	15276	♂? yeryold	Pribilof Islands	214	136	127	113	65	157	74	124	41	46	45	56	14	94	84	—	—
	49550[1]	♂♀? ad.	" "	203	123	123	110	65	143	81	118	40	47	45	47	14.5	94	86	131	44.5
	101330	♂♀? yg. ad.	" "	188	107	112	95	61	132	72	115	32	42	44.5	43	14	90	77	107	43.5
	98139	♂♀? ad.	Yakutat Bay, Alaska	193	107	113	98	62	135	73	115	33	43	44	43	10	89	75	121	41
	14399	yg.	Adakh Island, "	160	95	101	79	50	99	61	93	31	35	38.3	38	14	85	73	96	40
	6486	yg.	Washington	167	98	105	84	59	117	63	102	33	38	40	36	12	85	72	143	44
	61576	♂? old.	Santa Barbara Island	225	142	130	119	71	167	95	134	45.5	46	43	57	15	96	81	144	46.5
	81520[2]	♂ ad.	San Geronimo Is., L. Cal.	225	134	131	110	68	145	91	135	48	47	55	15	82	95	84	143	45
	81515	♂ ad.	" "	—	140	—	122	69	—	92	—	46	45.5	—	—	—	—	44	146	45
	81518	♀ ad.	" "	193	121	120	105	59	139	77	120	42	45	40	12	79	92	37	122	39.5
	81517	♀ ad.	" "	—	126	—	106	62	145	81	—	41	42	50	10	—	—	36	127	41.5
Phoca stejnegeri	21310[3]	♂ old.	Bering Island	250	149	139	136	85	185	103	149	51	51	53	62	17	90	97	167	50
	21312	♂ ?"	" "	223	145	125	116	77	168	84	134	48	53	48	—	15	84	88	149	—
	21335	♀ ? "	" "	223	—	—	118	74	167	90	132	43	47	48	51	15	83	—	145	46
	21311	yg.	" "	190	110	117	—	65	127	81	110	36.5	43	44.3	43	14.5	79	92	116	44

[1] Type of *Phoca richardii pribilofensis*.
[2] Type of *Phoca richardii geronimensis*.
[3] Type of *Phoca stejnegeri*.

NOTE.—Nos. 15276 and 21310, 14399 and 21311 are strictly comparable as to age and probably are of the same sex. The first two are very old, and the last two are very young, apparently not more than five or six months old.

MEASUREMENTS OF SKULLS OF *PHOCA 'VITULINA.'*

Mus. No.	Sex and Age.	Locality.	Basal length.	Zygomatic breadth.	Mastoid breadth.	Front border of premax. to pterygoid hamuli.	Front border of incisors to post. border of molar.	Front border of premax. to meatus audit.	Palatal length on median line.	Palato-max. suture to foram. mag.	Palatal width between molars.	Length of upper tooth-row.	Length of nasals.	Least interorb. breadth.	Length of brain-case.	Width of brain-case.	Breadth of rostrum at canines.	Length of lower jaw.	Length of lower tooth-row.
100 A	♂ ? very old.	Greenland	235	147	129	126	72	170	95	137	48	48	65	13	85	98	51	154	46
4713 N	♂ ? " "	Sable Island, N. S.	225	137	124	121	67	161	86	133	45	—	64	13	84	97	41	144	43
3634 N	♂ ? " "	"	223	144	125	124	73	161	88	131	47	49	67	12.5	85	99	45	—	—
102 A	♂ ? " "	Provincetown, Mass.	216	128	121	110	62	141	79	119	47	45	58	14	83	97	40	134	43
5144 C	♂ " "	Beverly, Mass.	217	139	127	117	75	163	80	—	—	—	60	15	82	92	45	135	—
3506 N	♂ ? yg.	Greenland	170	99	105	86	53	115	62	—	36	38.5	41	12	77	88	—	105	38.5
10137 A	♀ ? "	Holsteinberg, Greenland	174	103	109	88	57	117	68	104	38.5	40	42	10	77	91	31.5	111	37.5
82820 N	♂ juv.	Maine	169	102	105	87	58	120	69	96	39	40	48	14	75	87	31.5	106	39.5
82821 N	♀ "	"	169	98	104	87	56	119	67	96.5	36	41	43	11.3	72	87	31	106	40
15900 A	♀ "		177	100	106.5	94	58	129	73	105	36	40	45	12	75	88	31.5	112	40
14442 A	♀ "		171	99	107	88	55	123	65	102	38	37.5	48	12	77	87	30	111	37
6271 A	♂ "		168	99	103	87	56	120	65	98	38	40	46	14	73	86	34	106	40

A = Am. Mus. Nat. Hist. N = Nat. Mus. C = Mus. Comp. Zoöl.

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ERRATA.

Page 20, line 16, for schaphiotus read scaphiotus.
" 77, second footnote, for Hrdlikča read Hrdlička.
" 164, line 16, for *tajacu-angularis* read *tajacu-angulatus*.
" 197, line 9 from bottom, for **rostratum** read **rostratus.**
" 244, line 11 from bottom, for **hudsonius** read **hudsonicus.**
" 383, insert plate heading at top of page, as follows:
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